Read The Stranger Metals

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What Can We Use Them For?

▶ PRIMITIVE MAN in the stone age probably tossed away fine specimens of metalliferous ore because he was looking for flint. His great-grandson in the bronze age no doubt threw out iron ore because he was looking for nuggets of copper or tin. Uranium was the dross when pitchblende was being mined chiefly for radium.

Out of the one hundred elements known today, only about twenty are non-metals. Of the 80 whose properties are predominantly metallic, those in use for their metallic qualities can be counted with only a few more than ten fingers.

But chemists are scanning the lists of elements with speculative eyes. New properties, such as neutron absorption cross-sections, are demanded by the engineers who are designing apparatus where nuclear reactions must take place. Elements which are semi-conductors of electrons no longer do tricks to amuse laggard students. They are sought in earnest for uses only they can satisfy. Other special properties will undoubtedly come to light as more is learned about many of the others.

Photographs of the metal polonium and some of its typical halogen compounds, as seen through the microscope, appear in this issue of CHEMISTRY through the courtesy of Monsanto and of the American Chemical Society. These preparations are part of a series which will be definitive in establishing what this first of the unstable elements is really like.

Actinium, too, is coming in for its share of re-appraisal. By means of the marvellous new techniques of micro-chemistry, compounds can be reduced to metals, new compounds can be formed, crystal angles can be measured, and new substances can be analyzed, starting with a sample scarcely big enough to give evidence that it exists.

What can we use these new elements for? It is a safe bet that many elements will prove to have interesting and unexpected properties, and that before many years have passed some of the oddest-sounding names will have become household words.

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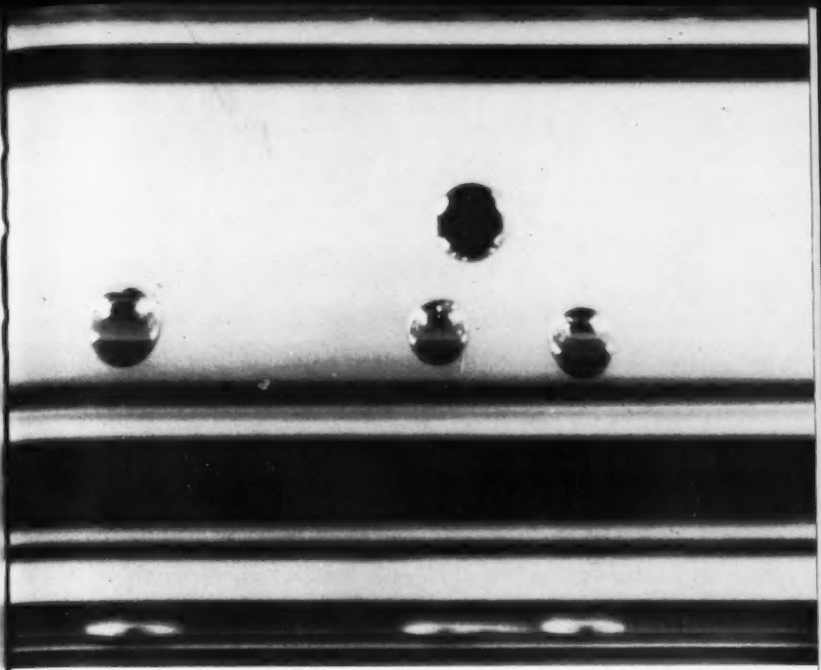

A STRANGER *among metals, polonium forms globules about the size of a grain of table salt when reduced in a fused quartz tube by chemists at Monsanto's Mound Laboratory.*

The Stranger Metals

by HELEN M. DAVIS

METALS seldom or never before seen are being prepared in visible quantities and put through their paces by men who have won them despite difficulties.

Metallic polonium and actinium, elements discovered by Mme. Curie and her associates in 1898, are now obtained in globules about the size of a grain of table salt. For these elements, this is large-scale production. They glow in the dark and would be hot to touch if one dared touch them. This amount represents a struggle against the extreme radioactivity of the metal.

Polonium is especially difficult to obtain because it continuously decomposes the water in which its compounds are dissolved. Its activity, continually giving off hearts of helium atoms, is 5,000 times as great as radium.

Polonium, however, lacks beta radiation which makes radium use-

ful in treatment of cancer. Occurring in nature in quantities of less than an ounce in 25,000 tons of ore, the two rare elements polonium and actinium are now made in atomic reactors.

The two metals were isolated by chemists of the Monsanto Chemical Co. Mound Laboratory, Miamisburg, Ohio. Metallic actinium was described by Joseph G. Stites, Jr. at the recent meeting of the American Chemical Society in New York City. E. Francis Joy made polonium tetrabromide and E. Orban and L. S. Brooks described other properties of polonium. The tetrachloride was shown at the earlier A.C.S. meeting in Kansas City.

These studies are part of Monsanto's program of research to determine precisely the chemical and physical properties of some of the least known elements.

Because the elements heavier than bismuth are rare in nature, their identification has often been based only on spectroscopic evidence, and description of their compounds has in some cases been sketchy.

Two factors allow the chemists at Monstanto's Mound Laboratory to make more definite determinations of the properties of these substances. One is the assured supply of the rare elements, now turned out by atomic reactors. The other is the delicacy of techniques which have recently been worked out for conducting chemical operations on microgram scale.

Now chemists can extract, purify and crystallize the wanted compounds in tiny amounts, yet obtain definite data.

When Marie and Pierre Curie were searching for the source of the mysterious "Becquerel rays," conditions were otherwise. The very fact that radioactivity is a property of the heaviest elements was just in process of discovery.

What is now called "tracer chemistry" was worked out as the Curies followed their unknown materials through the solutions and precipitations of standard analytical procedure. Presence of radiation showed itself by the rising and falling of the gold leaves of an electroscope, as the air became ionized.

The first evidence of a new element appeared when a radioactive presence remained with the fraction of the pitchblende ore that contained bismuth. Marie, the expatriate, hoped that, if it proved to be a new metal, it would be called for her native Poland.

Abandoning the bismuth fraction temporarily, the Curies kept pursuing the strongest radiations. They were ultimately rewarded with radium, which is close to barium in chemical properties.

Along the way they set aside another fraction with troublesome chemical properties. In this solution, André Debierne discovered actinium.

While radium became well known for the curative properties of its radiations, its two early companions have remained comparative strangers to the chemists.

It is these two neglected elements, overshadowed at first by radium and later by uranium, that the Monsanto chemists are studying.

In addition to forming the standard compounds, which will reveal the valences and nature of the combining powers of the elements, the research-

▸ HALOGEN *compounds of polonium are among the salts of the little known element being studied to determine its chemical behavior. Here the dark red crystals of polonium tetrabromide appear among the bubbles. Crystals of the tetrachloride are similar in form. Monsanto chemists hope to prepare a complete set of polonium compounds.*

ers have also produced the elements in the metallic state. They have thus again supplied evidence that, in each group of elements, metallic properties increase with atomic mass.

Polonium illustrates this tendency especially well, for it belongs to a family of elements whose lighter members are non-metallic. It is the heaviest analogue of sulfur, selenium

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and tellurium, which, with oxygen, make up Group VI. of the Periodic Table. Oxygen, sulfur and selenium are about as far from the metallic state as any elements can be. Tellurium begins to show metallic qualities. Polonium is a metal.

On the Back Cover

➤ RED POLONIUM *dichloride forms the large dark crystals, and mixed with these are small clear crystals of yellow polonium tetrachloride. These salts were made at the Mound Laboratory of Monsanto Chemical Co., where a new program of study of the least known elements is in progress.*

Chemicals in Opium Ash Aid Control

➤ A STOPPER for at least part of the world-wide narcotic drug menace has been discovered by Drs. J. C. Bartlet and C. G. Farmilo of the Food and Drug Laboratories, Canadian Department of National Health and Welfare.

The discovery is that the place where the raw opium came from can be determined by chemical analysis of the ash when the opium is burned. Indian opium, for example, has high potassium and low calcium content in the ash. The druggist type of Turkish opium, on the other hand, has a high calcium and low potassium content, Drs. Bartlet and Farmilo have found.

Knowing the source of the opium should help tighten control measures and suppress illegal production in those areas of the world where the illicit traffic in opium originates, the scientists point out.

Opium is produced from one species of poppy plant, Papaver somniferum, but the composition of its ash varies significantly, depending on the geographical origin of the opium. This variation in ash composition probably depends on varieties within the species and on such local features as soil, climatic conditions and agricultural techniques. In Iran the processing of raw opium probably has contributed to the variation.

The Canadian scientists have now analyzed more than 100 opiums from Yugoslavia, two regions in Turkey, Iran, India, Indo-China, Korea and China. Tests were made for both major and minor constituents. The elements determined were potassium, calcium, phosphorus, sodium, magnesium, silicon, iron, aluminum, titanium, boron, manganese, molybdenum, lead, tin and copper. Spectrographic, colorimetric and flame photometric procedures were used. The work was undertaken under a UNESCO program participated in by member governments.

Test Needed For Tension Cause

Chemical Aid to Medical Treatments

▶ MOST NEEDED now for treating high blood pressure is a test for telling which basic mechanism is producing the high pressure in each patient, Dr. Irvine H. Page of the Cleveland Clinic, Cleveland, Ohio, declared at the World Congress of Cardiology in Washington recently.

Doctors now have a score of drugs which reduce blood pressure. But they do this by acting on different mechanisms in the body. The big problem is to find the right drug for each patient.

For example, reserpine and other drugs from the snakelike root of the Indian plant, *Rauwolfia,* act on the brain and central nervous system. The quieting or tranquilizing effect of these compounds seems to be what some patients need to reduce their high blood pressures.

Apersoline, or hydralazine, acts on another part of the nervous system and also inactiviates a pressure-raising substance in the blood.

Acting to block sympathetic nervous system impulses at the ganglia, well back of the blood vessels, are still other chemicals: hexamethonium and a newer one, pentapyrrolidinium.

Many doctors at the Congress were enthusiastic about pentapyrrolidinium, known also as M. and B. 2050 and Ansolysen. One of its advantages is that it can be taken by mouth and another is that its effect lasts longer.

All the blood-pressure-reducing drugs seem to have some unpleasant side effects. These range from drowsiness to impotence and even production of a disease like arthritis. Doctors prescribing them, consequently, must find not only the right drug for the particular patient but also the delicate balance in size of dose between that needed to reduce pressure and that which can cause unpleasant or serious side effects.

Save Nerve Gas Victims

▶ A CHEMICAL that can step up the anti-nerve gas action of atropine two and one-quarter times has been discovered.

The chemical is called pentamethonium, short for pentamethylene bis-trimethyl ammonium dibromide. It is related to one of the newer drugs used for lowering very high blood pressure, hexamethonium.

Its ability to increase the life-saving effect of atropine in laboratory animals poisoned by a nerve gas type chemical, paraoxon, is reported by Drs. C. A. de Candole and M. K. McPhail of Suffield Experimental Station, Ralston, Alberta, Canada.

Atropine has heretofore been considered a specific antidote, and the only antidote, for nerve gases and other anti-cholinesterase chemicals such as some of the newer insecticides.

"Pentamethonium bromide significantly increases survival of fully atropinized animals—mice, rabbits and cats—poisoned with paraoxon," the Canadian scientists declare.

Its good effects come through its aid to breathing. In this respect it produces better results when given with atropine than atropine alone does.

Clue to the trial in animals of pentamethonium as an auxiliary antidote to nerve gas type chemicals came from findings of other scientists that it showed competitive antagonism with acetyl choline at nerve centers. Nerve gas type chemicals, by blocking cholinesterase, allow too much acetyl choline to collect at such centers.

Test For Heart Damage

➤ A BLOOD TEST for heart damage that may save patients weeks and months of unnecessary invalidism was announced at the International Congress of Cardiology.

The test was developed by Drs. John S. LaDue, Felix Wroblewski and Arthur Karnen at the S'oan-Kettering Institute, research unit of Memorial Center for Cancer and Allied Diseases, New York. It is a by-product of cancer investigations. The test will be used to determine whether the patient has heart damage due to a heart attack of the kind doctors call coronary thrombosis, meaning a block in one of the blood vessels nourishing the heart muscle. Usual diagnostic methods for determining this are sometimes inconclusive and in such borderline cases, patients now may be put to bed for weeks or until the doctor is sure their hearts are not damaged. The new test will avoid this.

The new test is made on a sample of blood and can be performed in the doctor's office or the patient's home. It depends on the amount of an enzyme, glutamic oxaloacetic transaminase, found in the blood. Normally, this enzyme is found in highest concentration in heart muscle. When the heart muscle is damaged, it is liberated into the blood stream.

Tests on 50 patients with heart damage showed two to 25 times the normal amount of the enzyme in the blood within 12 to 24 hours after the heart attack. Every patient tested who was known to have heart damage (mycardial infarction) showed above normal amounts of the enzyme in his blood.

Patients with arteriosclerotic and other types of chronic heart disease, however, all had normal amounts of the enzyme in their blood.

Clue to Anti-Cancer Agent

➤ SALIVA in the human mouth holds a clue to a possible anti-cancer agent, it appears from studies at Ohio State University's College of Dentistry at Columbus.

By its continuous cleansing action, saliva itself may check cancer-producing agents in the mouth.

Dr. Steve Kolas suggests this on the basis of studies he has just completed. The finding may explain why cancer of the mouth has not increased in the way lung cancer has parallel with the increase in tobacco consumption, he thinks.

Using mice, he applied a cancer-causing chemical to the roof of the mouth of each mouse, letting the chemical spread to other parts of the mouth and face. Six months later, no cancers or other significant changes had developed in the mouths of the mice, but cancers had developed on the skin of the faces.

The continuous cleansing action of the salivary flow, which diluted and removed the cancer-causing chemical at the same time, is, in Dr. Kolas' opinion, the chief reason why no cancers developed in the mouths of the mice.

But saliva may contain an anti-cancer agent. None has so far been found but Dr. Kolas believes further search should be made. If such an agent exists and can be isolated, it might not only save the lives of the 5,000 to 6,000 Americans who die each year of oral cancer but might also have wide applications in the continuing fight on all forms of cancer.

Cortisone Lowers Defense

▶ CORTISONE, adrenal gland hormone famous for its relief of pain and crippling in arthritis, "probably" lowers the defense of the body against infection and new growths, such as cancer.

Studies showing how this happens are reported by Drs. T. Nicol and R. S. Snell of King's College, London, in the scientific journal, *Nature*.

Their studies were made on guinea pigs. In these animals they found that cortisone depressed the activity of the blood cell forming reticulo-endothelial system, particularly the spleen. This system has previously been reported to be an important defense mechanism of the body against growth of tumors, including cancers.

Study of cortistone's effect on this system was made because of reports that patients being treated with cortisone are more susceptible to infection and that cortisone enhances the spread of transplanted tumors in animals.

Two-Drug Mixture for Sleep-of-Death

▶ DISCOVERY of a double drug mixture to waken people from the sleep of death brought on by overdoses of barbiturate sleeping medicines has been announced by Dr. F. H. Shaw of Melbourne, Australia.

Already some 20 patients have been rescued by the mixture. The two drugs are beta beta methyl ethyl glutarimide, known as NP 13 for short, and 2-4 diamino 5 phenyl thiazole.

NP 13 is an antagonist to barbiturates. The thiazole compound, discovered about two years ago, is an antagonist to morphine but only slightly antagonistic to barbiturates. When given with NP 13, the thiazole compound reinforces the action of the NP 13 and adds the additional safety factor of counteracting the convulsions which large doses of NP 13 can cause.

Important feature of NP 13 is the fact that it counteracts the depressed breathing brought on by barbiturates. In some cases when NP 13 was given to counteract barbiturate overdosage, the breathing rate was doubled for five to 10 minutes after injection of NP 13.

Associated with Dr. Shaw in the discovery and testing of the new double drug mixture were Shirley E. Simon, N. Cass and A. Shulman of the University of Melbourne and J. R. Anstee and Eva R. Nelson of Nicholas Ltd., Melbourne.

Molecule Built of Seven Fused Rings

Synthesis of Strychnine Achieved

➤ Poisonous strychnine can be made synthetically, but this achievement of organic chemistry will not result in this alkaloid being made in the laboratory instead of being extracted from seeds of plants.

The total synthesis of strychnine in 30 steps was accomplished by a team of Harvard University chemists led by Prof. R. B. Woodward, and it is more complicated than his earlier building-up of quinine and cortisone from fundamental materials.

The strychnine molecule is an intricate web of 21 carbon atoms, 22 hydrogen atoms, and two each of nitrogen and oxygen.

Strychnine, one of the first alkaloid substances to be isolated in pure state by Pelletier and Caventou in 1818, has long presented a challenging problem to chemists.

Strychnine is a white, crystalline, bitter and poisonous alkaloid. It occurs in the seeds of a West Indian plant, *Strychnos nux vomica,* and in the bean of the Philippine plant, *Strychnos ignatii*. Taken internally, it produces excessive irritability to the spinal cord resulting in convulsions.

It has limited medical use, and the medical demand for strychnine is easily met from the natural product. The laboratory process gives uneconomically low yield of the substance in terms of the expenditure of time and money.

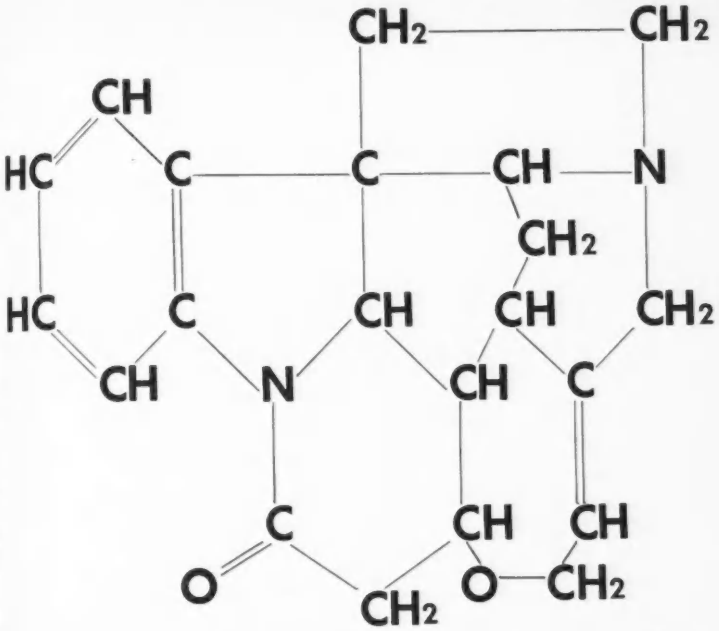
Working with Dr. Woodward, during three years of research, were Michael Cava, A. Hunger, W. D. Ollis, H. U. Daeniker and K. Schenker, all of whom were or are postdoctoral fellows of Harvard's Converse Memorial Laboratory.

The problem was essentially like completing a jig-saw puzzle in organic chemistry. The number of pieces was known. More than 100 years ago strychnine had been broken down by ultimate analysis to give the formula $C_{21}H_{22}O_2N_2$.

German chemists before World War I, especially Tafel, worked out methods of splitting off sections of the molecule. Complicated organic compounds were thus analyzed. Each molecular splinter contributed to understanding the particular section of the original compounds from which it had been formed. Gradually the alkaloids, among the most intricate organic structures, were understood, at least in part. German researches have been kept up especially by Dr. H. Leuchs.

In 1909 W. H. Perkin, discoverer of the first of the "coal tar" dyes, turned his attention to the structure of strychnine, in England. The work there has been continued by Sir Robert Robinson, who was his pupil at the time.

In addition to the German and the British researchers, Dr. Woodward's



THE STRUCTURE *of strychnine has taken more than one hundred years to work out completely. The empirical formula was achieved early, and the location of the double bonds was not too difficult. But the complicated network of that corner of the molecule represented here as the upper right-hand corner of the formula has only now been completed. A clue from the structure of a different compound suggested a way in which the final pieces of this chemical jig-saw puzzle might go together. Then followed the synthesis of a compound from non-living chemicals that has the same properties as the alkaloid made by the plant.*

team at Harvard has taken part in completing the puzzle. Since 1930 the problem has been to fit in the last three carbon atoms, with seven satelite atoms of hydrogen, into the last and most unusual corner of the strychnine molecule.

The crowning achievement of Dr. Woodward and his students is that they not only have solved the jig-saw but have built up from simple, non-living chemicals a synthetic strychnine which duplicates in every particular the behavior of the alkaloid formed by the vital processes of the plant.

TB Germ Acid May Lead to Better Cures

Life Processes Traced Chemically

➤ A BETTER understanding of how the body is damaged in tuberculosis and some future hope of new weapons against the disease is coming out of research at the University of California.

Dr. James B. Cason, professor of chemistry at Berkeley has isolated from the tuberculosis germ a rare acid that causes TB lesions in animals.

He has a'so worked out some of the architecture of the acid molecule, and has built a synthetic model containing all of the molecule's known structural features.

The synthetic molecule and similar molecules are being tested in animals by Dr. Sanford Elberg professor of bacteriology. The tests are not comp'ete, but they already show that small differences in geometrical molecular shape can cause very large variations in reactions of the animals.

An implication of the work is this: if the chemical proves beyond question to be responsible for the TB lesion, tuberculosis may at some time in the future be fought on new grounds.

The scientists cautioned, however, that a great deal of work remains to be done, and that no treatment could be based on their research to date.

The work is an outgrowth of research begun about 20 years ago by Dr. R. J. Anderson at Yale University and Dr. Florence Sabin of the Rockefeller Institute. Dr. Anderson isolated a mixture of branched chain fatty acids from tuberc'e bacilli, and Dr. Sabin found they caused TB lesions in animals.

But not until Dr. Cason isolated a pure component from the mixture, was it possible to tell precisely which acid was responsible for the damage. The acid appears to be the agent, or one of the agents, by which the bacillus harms the body.

Dr. Carson and his co-workers have separated the fatty acid from five different virulent strains of tuberculosis. It was not found in two non-virulent strains. Other strains must be investigated to determine if the acid makes the difference between virulence and non-virulence.

The research is very tedious because only minute quantities of the acid are present in the bacilli. Two pounds of bacilli will yield only about one-hundredth of an ounce of the toxic acid. Only about five-hundredths of an ounce have been isolated so far.

Heart Poison in Strep Germ

➤ DISCOVERY of a powerful heart poison in a chemical from the streptococcus germ was announced by Drs. Aaron Kellner and Theodore Robertson of New York at the World Congress of Cardiology.

This poison may be the cause of the heart damage following rheumatic fever attacks, the New York doctors believe.

Since 1934 doctors have known that

an attack of rheumatic fever almost always was preceded by certain types of streptococcus infection. The exact relation between the "strep." infection and rheumatic fever and rheumatic heart disease, however, was not known.

Today it appears that the missing link has been found in this strep. germ heart poison. The heart poison is a protein-digesting enzyme. It was isolated in crystalline form in 1950 by Dr. S. D. Elliott of the Rockefeller Institute, New York. He called it streptococcal proteinase.

Drs. Kellner and Robertson injected this strep. germ enzyme into the veins of rabbits, mice, guinea pigs and cats. It caused "striking" damage to the muscles and valves of the animals' hearts, with an inflammatory reaction. With only a few exceptions, the enzyme's destructive action was confined to the heart, other parts of the body being unharmed.

When the enzyme was added to the fluid in which an isolated rat heart was being kept alive and beating, contractions soon decreased in strength and frequency and heart failure occurred within a few minutes.

Rheumatic fever attacks 30,000 Americans yearly, most of them between the ages of five and 15. It is responsible for an estimated 1,000,000 cases of rheumatic heart disease in the United States.

Germs Resist Heart Drug

➤ DEATHS are mounting again from an almost conquered heart disease as germs grow resistant to heart-saving penicillin and other antibiotic drugs.

This bad news was brought to the World Congress of Cardiology by Prof. Luis Trias de Bes of Barcelona, Spain.

The heart disease he reported on is subacute bacterial endocarditis. This is an inflammation of the lining of the heart that sometimes develops as a complication of rheumatic or congenital heart disease.

This once almost always fatal disease was practically conquered when penicillin and other antibiotics came on the scene to rout the germs that caused the inflammation.

But in the last five years, doctors have been able to cure only about half instead of 70% of the cases, Dr. Trias de Bes reported.

Fortunately, there are fewer cases of the disease today. But Dr. Trias de Bes warned:

"We face the serious risk that this disease will regain the high malignancy that characterized it before the discovery of antibiotics."

Radiocarbon in Tissues

➤ A HIT-OR-MISS effect in bringing together the ingredients of living tissue has been detected. It was revealed by tracing the build-up of protein from simple materials containing tell-tale radioactive carbon.

Uniformity in the distribution of this tracer carbon is not found when protein is first built in the laboratory from simple amino acids containing it.

These discoveries were reported by Dr. Daniel Sternberg of the National Heart Institute, National Institutes of Health, Bethesda, Md. He described his studies on protein structure be-

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fore the division of biological chemistry of the American Chemical Society.

Test-tube-created proteins in Dr. Sternberg's laboratory must, he believes, be formed with intermediate stages between the free amino acids and the completed protein, or else some of the reactions must reverse themselves at some stage and exchange carbon atoms "at different rates for different residues in the protein."

After eight or ten hours the radioactive carbon is found to be more evenly distributed in his synthetic protein, Dr. Sternberg states. This leads him to believe that in the laboratory the process of protein formation goes in "slow motion" compared to the rate in living tissues.

Study of the steps by which these complex life chemicals are built may lead to new understanding of the difference between normal and abnormal growth.

▶ "I'M ALREADY *'Wholesomely Appealing' — I want to be 'Intoxicatingly Glamorous'!"*

Chemicals Fight Weeds And Destructive Insects

Pesticides Improve Living Conditions

▶ TROPICAL agriculture is being eyed by chemists as offering potential markets for pesticides and weed control chemicals.

Weeds, diseases, insects, rats and bacteria take their toll of crops in the warmer regions of the earth.

Coffee alone is ravaged by more than 60 diseases. Sugar, cacao, rice, bananas and citrus fruit are export crops from the tropics, just as are cotton and rubber, and each has its share of trouble that chemicals could help.

Better yields of food crops are necessary for better living conditions in many parts of the world, experts on population agree. Cutting down the waste that is now consumed by pests would go far toward giving the human inhabitants of backward countries a better food supply.

Many chemicals have been developed to combat the enemies that plague farmers in temperate zones. None of them is without some drawback, but together they offer a wide choice of methods of attack.

For tropical conditions these methods must be reviewed to see which can be carried over and which, for one reason or another, cannot be used.

Some are too expensive in the quantities needed. Some need to be formulated with adhesives to keep them on the plants during the rainy season. Some find opposition from local farmers, due to custom, religion or superstition. Some farmers never get a chance to learn about the helpful discoveries they would be glad to use.

Discussing these problems at a recent meeting of the American Chemical Society were chemists from the tropical Americas. They took part, with others, in a symposium on use of pesticides in tropical agriculture. Dr. Norwood C. Thornton, United Fruit Co., presided.

Dr. John S. Niederhauser and Dr. Douglas Barnes of the Rockefeller Foundation reported on the use of pesticides on basic food crops in the tropics. They concluded that, as knowledge of the control of insect pests and diseases in the tropics is increased, "it will be possible not only to lengthen the growing season of basic food crops, but almost certainly to diversify the kinds of crops grown. These two steps will create a more stable agricultural economy and give stimulus to agricultural progress" in the opinion of these scientists.

Factors influencing the demand for pesticides in tropical agriculture were reviewed by Dr. Edson J. Hambelton of the U.S. Department of Agriculture. Special problems of particular crops were presented by scientists from the tropical countries where these are grown.

Government Grows Weeds

▶ WHILE MOST persons want to get rid of weeds, the Department of Agriculture is carefully raising them. In an effort to find new methods of

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Some are too expensive in the quantities needed. Some need to be formulated with adhesives to keep them on the plants during the rainy season. Some find opposition from local farmers, due to custom, religion or superstition. Some farmers never get a chance to learn about the helpful discoveries they would be glad to use.

Discussing these problems at a recent meeting of the American Chemical Society were chemists from the tropical Americas. They took part, with others, in a symposium on use of pesticides in tropical agriculture. Dr. Norwood C. Thornton, United Fruit Co., presided.

Dr. John S. Niederhauser and Dr. Douglas Barnes of the Rockefeller Foundation reported on the use of pesticides on basic food crops in the tropics. They concluded that, as knowledge of the control of insect pests and diseases in the tropics is increased, "it will be possible not only to lengthen the growing season of basic food crops, but almost certainly to diversify the kinds of crops grown. These two steps will create a more stable agricultural economy and give stimulus to agricultural progress" in the opinion of these scientists.

Factors influencing the demand for pesticides in tropical agriculture were reviewed by Dr. Edson J. Hambelton of the U.S. Department of Agriculture. Special problems of particular crops were presented by scientists from the tropical countries where these are grown.

Government Grows Weeds

➤ WHILE MOST persons want to get rid of weeds, the Department of Agriculture is carefully raising them. In an effort to find new methods of

weed control, the Department's Weed Investigations Section at the Plant Industry Station, Beltsville, Md., plants, cultivates and then tries to eliminate weeds.

Dr. M. W. Parker, head of the Weed Investigations Section, described the operation, which was set up in 1950, as an attempt to find new ways of depriving weeds of the right to compete with food, fiber, forage and ornamental crops.

Specific varieties of weed seeds are sent to the section from field collectors on request.

Often, wild weeds will make their appearance in a cultivated weed plot. Dr. Parker pointed out that there is no effort to weed out these wild cousins. A large part of the program is the testing of herbicides, weed-killing chemicals, for effectiveness.

The station receives these chemicals from various industries, institutions and research organizations. These are then tested on a specific weed, which is harmful to certain crops.

Weeds are cultivated in flats in greenhouses along with a number of crops such as alfalfa, cotton, red clover, and beans. A new herbicide is then tested as a weed-killer, to determine whether it will eliminate such known weeds as crabgrass or pigweed, or perhaps both. If preliminary tests are favorable, the herbicide is then reapplied to a larger variety of weeds and crops in field plots.

All herbicides are tested on specific, common weeds. "We do not gamble on natural infestation," Dr. Parker explained.

Dr. Warren C. Shaw, agronomist with the Weed Investigations Section, stated that there were three possible methods of weed control with the herbicides: pre-planting, pre emergence, and post-emergence.

When testing for pre-planting control, the herbicide is applied before the crop seeds are sown. Pre emergence control applies to herbicides that are used after the seeds are sown, but before they begin to grow, and post-emergence control of weeds employs the herbicides after the plant has started to develop.

In a search for a new weed-killer, a herbicide is tested for all three ways of possible elimination.

In a recent test, a pre-planting herbicide, six pounds of CIPC per acre, was sprayed onto a good seed bed. Red clover was then transplanted from the greenhouse into furrows in the plot. Three weeks were allowed to go by without cultivation or soil treatment. At the end of this period, it was found that the herbicide had been effective in preventing grasses and broadleaf weeds from emerging. Drs. Parker and Shaw stated that pre-planting herbicidal control had been very effective in this instance because it protected the young seedlings. Similar herbicides have proven useful during wet weather, when cultivation is almost impossible.

Printed circuits will replace complicated wiring in TV sets at lower costs.

A tornado is an intense spiral motion around a vertical or inclined axis, averaging 250 yards across at its lower part.

Launch Five-Year Study Of How Human Eyes See

Vision is Chemical

▸ A FIVE-YEAR study of exactly how the human eye sees is being launched at the University of California at Los Angeles.

This comprehensive investigation of the mechanism of vision is under the direction of Dr. Frederick Crescitelli, professor of zoology, and is supported by the U. S. Public Health Service.

Key to the visual process, Dr. Crescitelli points out, lies in pigments stored in visual sense cells, the rods and cones, so-called because of their shape.

Much is known about pigments in the rods, whose function is concerned with seeing in dim light. Visual purple is the primary rod pigment. A series of colorful chemical changes, initiated when light hits this sensitive pigment, apparently furnishes energy to send impulses to the brain via the optic nerve.

However, little is known about the cone pigments, which are responsible for seeing in the daytime and for color vision.

Initially the investigation will be concerned with a broad range of animals in an effort to isolate and compare different types of visual pigments and to determine their role in visual processes.

Like Color TV Set

▸ YOUR OPTICAL system for seeing colors works essentially like the mechanics for color television transmission, according to a new theory proposed by a University of California scientist.

Color perception, explains Dr. Gordon L. Walls, professor of physiological optics and optometry, is one of the most baffling aspects of human vision. His theory is the result of years of study of color blindness and color vision.

Most ideas about color perception hold that the eye contains separate receiving elements for color and for brightness.

Dr. Walls' evidence, however, indicates that color and brightness are received by the same elements in the eye but are transmitted to the brain over separate, "branched" pathways. In such an arrangement, brightness messages and color messages can be amplified independently along each one's own pathway.

Color television transmission requires essentially the same separation, independent amplification, and recombination of brightness and color signals as Dr. Walls' "branched pathways" theory would provide in the visual system.

"So it appears," Dr. Walls said, "that millions of years ago, nature found out that brightness and color messages could not be sent over the same routes and still have everything in proper balance for a perfect picture. Only recently, however, have the television engineers learned that."

Dr. Walls obtained much of his evidence from studies of women who are genetic carriers of color blindness. "Carrier women" theoretically should be normal but sometimes are color blind in peculiar ways. Thus, for example, impaired brightness vision with no defects in color vision, and vice versa, are found.

Such cases can be explained, the California scientist believes, only by the presence of a branching system and transmission lines to the brain from a single set of color-brightness receiving elements in the eye.

Dr. Walls believes all the main facts of color vision and color blindness appear to fit into the branched pathways theory. Nor has he been able to find a single "special" case of congenital color blindness that cannot be explained by the new theory.

The scientist hopes the theory will serve to re-direct studies of color-blindness toward a full understanding of the color vision phenomena.

Black Eyes Healed by Digestive Enzyme

➤ Instead of beefsteak, eye specialists at Philadelphia General Hospital have been trying shots of a digestive enzyme, trypsin, for black eyes. It worked in five cases, and also gave "impressive" results in seven cases of other eye conditions including hemorrhage of the retina which caused sudden loss of vision.

The eye specialists, Drs. Joseph M. Hopen and Francis N. Campagna, reported the good results in the hospital's journal with the object of encouraging use of trypsin. They used a specially prepared purified crystalline trypsin from beef pancreas, called Parenzyme by its manufacturer, the National Drug Co. of Philadelphia.

In one case, a 45-year-old man suffered a severe beating about the face and eyes. Both eyes were swollen shut, and cuts in the eyelids were difficult to suture because of the liquid-filled swelling. Improvement was noted after 24 hours of Parenzyme therapy, and in 48 hours the patient was well on the road to recovery with one eye fully open.

For comparison, another patient was first treated by conventional means. He had been hit with a blackjack, and the eye socket had swollen to the size of a lemon. Every form of treatment including the enzymes streptokinase and streptodornase was given without improvement, and surgery performed to relieve pressure also provided no relief.

After a week, this patient was started on Parenzyme therapy. Again improvement was noted in 24 hours, and the swelling had subsided enough to allow closure of the eyelids in six days.

The trypsin solution is injected into the buttock rather than the distressed region. Thus the delicate tissues near the eye, already painful because of the affliction, need not be irritated by the needle.

New Kind of Jaundice Has Golden Fleece Link

Unknown Liver Pigment

▸ A NEW KIND of jaundice has been discovered in young people. It may be related, chemically, to a hereditary golden fleece condition of sheep.

The important thing about this new jaundice, however, is that the outlook is good. Those who have it can live normal and presumably long lives, though their skin and eye whites may turn yellow now and then. They do not need an operation and they do not need to spend weeks in bed. Their jaundice is not "catching."

The golden fleece link comes from examination of the livers of these people. Their livers contain a pigment, or color chemical, which so far has defied identification. But it may belong to the family of color chemicals called mesobilifuscins which the sheep with golden fleece excrete.

The golden fleece jaundice of humans was discovered by Drs. I. N. Dubin and Frank B. Johnson of the Armed Forces Institute of Pathology in Washington, D.C. They do not call it golden fleece jaundice. Their name for it is "chronic idiopathic jaundice with unidentified pigment in liver." Translated, that means it is a chronic condition without, so far, any known cause and in which there is an unknown color chemical in the liver.

Discovery of this new kind of jaundice, however, may save many people from operations, long weeks in bed and chronic invalidism. It may save the Armed Forces many a healthy serviceman and it may save the Government many a dollar in pensions. All this because heretofore the new jaundice has been confused with or misdiagnosed as viral hepatitis or obstructive jaundice.

The new jaundice was discovered by some medical detective work, although no one had sent Drs. Dubin and Johnson on a new disease hunt.

Dr. Dubin's special job at the Armed Forces Institute of Pathology is to handle the bits of tissue on glass slides (sections, medical men term them) from the liver and bile tract that are sent to the AFIP from Armed Forces installations all over the world. So many of these arrive, especially now that viral hepatitis has become a widespread disease, that he sees more of the specimens and slides in two years than any other man might see in a lifetime.

Poring over these slides with his microscope, Dr. Dubin one day saw something he had never seen before. It was a section of perfectly normal looking liver except that its cells contained striking amounts of brown material that he could not identify. The slide gave a picture unmistakably different from all the others.

When he saw a second one like it, he went to the files at the AFIP and dug out all the slides of liver sections. He found that within the last two to

three years, about a dozen of these strange liver sections had come in.

Next step was to get out the histories, or medical records, of the patients from whom the specimens came. Reading these over, he and Dr. Johnson saw that the symptoms and laboratory tests fell into a common pattern.

The patients were all young. Almost all had had jaundice off and on for some years. One stated he had yellow eyes since birth. Abdominal pain and fatigue were common symptoms, along with the jaundice, dark urine and slight enlargement of the liver. In many the jaundice had flared up during an attack of some other sickness, such as scarlet fever or pneumonia, or under the stress of unusually hard work.

Chemical tests of the blood indicated something wrong with the liver. There was an abnormally large amount of the bile pigment, bilirubin, in the blood serum. X-ray examination after a dye had been given always failed to show the gall bladder. With signs of non-functioning gall bladder and of possible obstruction to the bile flow, the doctor of such a patient had "practically no choice" but to advise operation to see what was wrong and to remedy it if possible.

But at operation, these patients always proved to have perfectly normal gall bladders and bile ducts and normal looking livers except for the color. This varied from green to greenish-black to slate blue.

This color is so characteristic that now a doctor taking out a bit of liver with a needle (a simple examination now made frequently for diagnostic purposes) can tell from the tiny disc he has removed that the patient has this new jaundice. Examination of the tiny piece under the microscope shows the brown pigment which confirms the diagnosis.

Before Dr. Dubin's discovery, patients with this condition not only had needless operations and spent months in bed while doctors made every known test and tried every known treatment. They also would finally be sent home from the hospital with some grim-sounding diagnosis such as chronic viral hepatitis.

To some, this meant they were crippled and unfit as surely as if they had lost a leg. Some felt they could never work again and must have a pension. Others, young men in the Armed Forces, were disgusted at being kept off duty or separated from the service for an ailment that did not make them feel sick except once in a while and for occasional yellowing of skin and eye whites which they had had all their lives.

The cause of the condition is not known. Drs. Dubin and Johnson believe it is some inborn defect of the liver which makes it unable to handle certain color chemicals, including the dye used to visualize the gall bladder under X-rays.

They stress that it is not serious and that the patients should not be operated on, and should not be converted into physical or mental cripples by a false diagnosis.

So far, 16 cases have been discovered, 12 of them in a check of about 5,000 medical records. While this is not a large number, Drs. Dubin and Johnson think there are many more that have not been recognized or have been misdiagnosed.

Reactor Development Program Trying Out Many New Designs

Nuclear Reactors Being Built

Excerpts from remarks prepared by Lawrence R. Hafstad, Director, Division of Reactor Development, United States Atomic Energy Commission, Washington, D.C., U.S.A. For Delivery Before the Congress of Industrial Chemistry, Brussels, Belgium, September 16, 1954.

▸ It is in the scientific tradition that there should be international cooperation in basic science. This tradition means, in essence, international cooperation in uncovering and deciphering the secrets of nature. It assumes free interchange of information among scientists of various countries. Above all, it calls for travel and free access to laboratories. Without personal discussion with the men who write scientific papers and knowledge of the facilities with which they work, it is difficult for other scientists to understand fully and to appreciate the highly technical reports in our scientific journals and to criticise them effectively and constructively.

Before the advent of atomic energy, it was accepted fully by the scientific and technical community that, in the area of applied science, there would be competition among nations and among companies and enterprises within a nation. There was no resentment against trade secrets as such, but there was tacit assumption that handbook-type physical constants should be available to all. So far in atomic energy the equivalent of the *International Critical Tables*, for example, has not appeared. This situation is understandably resented by research scientists of all countries. They feel that their time is being wasted in painstakingly duplicating work which they are sure has been done, not once but many times, by scientists in other countries.

Competition Vs. Cooperation

Here is an area in which those of us who believe in the basic rightness of the traditional approach have opportunity to make a contribution apart from our science and engineering. We should first define in our own minds the areas in which we scientists and engineers believe international *cooperation* is justified and separate these from areas in which international *competition* appears justified. We should then, as professional people, satisfy ourselves that cooperation is complete in the areas designated. Further, we must make sure that there are no "free riders," who receive but do not contribute.

Until a mechanism for such cooperation can be achieved, it will be necessary to operate within the rules of a somewhat improvised security policy which in the past has sometimes oscillated in an unpredictable manner between excessive security and excessive release of information. . . .

As for a description of the reactor development program itself in the United States, I shall not take up

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your time with details, since your scholars are diligent students of the open literature. However, for the benefit of any neophytes in the audience, I shall merely report that the 5 year program includes three short-term projects and two long-term projects, all aimed at developing economic electric power from nuclear fuel as soon as possible. Those of us charged with guiding the program believe that if any one of the projects emerges as assuring truly economic electric power, our assignment will have been successfully completed, for new forces will then come into play to assure the healthy advancement of the program.

Pressurized Water Reactor

The first short-term project is the Pressurized Water Reactor being developed by Westinghouse and to be built by Westinghouse and the Duquesne Light Company, near Pittsburgh. This plant, with a capacity for at least 60,000 kilowatts of electricity, should be completed in 1957. Construction was started recently with ceremonies in which President Eisenhower participated. We have been careful to stress that, in spite of its size, this plant is strictly experimental. The power it will generate is not expected to be competitive.

Sodium Reactor Experiment

The second short-term project is the Sodium Reactor Experiment which combines the graphite technology from our long experience with Hanford reactors and the sodium coolant technology from the development of fast breeder reactors by Argonne National Laboratory and the sodium-cooled submarine reactor by the General Electric Company. Construction was started this summer near Los Angeles, California, by North American Aviation, Inc., the developer.

Boiling Water Reactor

The third short-term project is the Experimental Boiling Water Reactor in which the Argonne Laboratory is attempting to dispense with the heat exchanger between the primary and secondary coolant loops. This means that steam will be taken to the turbine directly from water boiling in the reactor itself.

The long-term approaches also seek unique cost-saving features. In developing homogeneous reactors, the fuel is incorporated in an aqueous solution in an effort to avoid part of the fabrication and reprocessing costs. In a fast breeder reactor it is expected that the neutron economy can be so closely controlled that more fissionable material will be produced from fertile material than is consumed. . . .

Different Approaches

You will recognize that each of the five projects described represents a technical approach very different from the other four approaches. Considerable research and development is necessary in each approach in order to build the reactors. It is important to realize that none of these reactors is expected to produce economic power. It is for this reason that we are labeling them "experimental." We are buying information with them, not electric power. Of course, it is possible that developments may call for some revision of the program from time to time. Constant review is necessary.

We expect to carry out the program

with government funds, subject, of course, to Congressional approval. Concurrently with or immediately after the program we hope to be able to persuade industry to pick up the load of further development leading to full-size reactors. Accordingly, we are endeavoring to develop the most promising reactor designs to, and in some cases through, the pilot stage, expecting private industry to carry on from that point. . . .

I am often asked which of these reactors I consider the most promising. This is a question that is impossible for me to answer. I don't think anyone really knows. If we could be sure which approach is going to be the best in the long run, it wouldn't be necessary to build different types of reactors. I can make some generalizations, however, which may be of interest to you.

The Fuel Element

It is beginning to be clear that the major technical problem lies in the fuel element itself. We need a fuel element which will stand high temperature, have long-life—that is permit high burn-up—and be cheap and easy to fabricate and reprocess. No fuel element we have yet been able to devise is adequate in all these respects. The homogeneous reactor approach, while avoiding these particular troub'es, encounters other troubles of its own due to corrosion caused by hot, radioactive fuel solutions.

The other major problem is the hazard, or safety, problem—and its associated problems of high insurance costs and public liability. In this area, much work remains to be done. A refreshing new approach to this problem was initiated by my distinguished colleague, Dr. Zinn, Director of the Argonne National Laboratory, in a series of experiments on reactor transients.

It seems to me that the fuel element problem can be so!ved best by vigorous trade secret type of competition. On the other hand, I think that the safety problem should eventually call for international exchange of information. . . .

Safety Problem

I take it that there is a fervent desire on the part of all reactor engineers and scientists to utilize this new energy source for the good of humanity. Therefore, I believe that, in spite of the rather obvious difficulties, all of us can and should exert special effort to make international cooperation in this field work.

To prevent disappointment, however, all persons not experienced in reactor development are warned that the day of cheap electricity from atomic energy sources has not arrived yet. As I indicated a few moments ago, much work remains to be done to reduce the cost of constructing and operating reactors to a point at which they will be economic. Even after economic plants are built, it will be necessary for the people operating them to have a fair understanding of the principles upon which they function and to be able to avoid any hazards that may remain inherent in these new machines. It is for these reasons that we, as technical people, urge newcomers in the field to learn to walk before they try to run.

In developing cooperation among nations, we should be able to arrange

a fairly free interchange of information in the area of basic research. This is the first step.

The second step is the construction and operation of low power research reactors from which engineers can learn at first hand the nature, operating difficulties, and limitations of reactors in general. These research reactors need not be large or spectacular to be useful.

Zero Reactors

It may surprise some of you to learn that in the United States we have found very low power reactors to be effective tools in developing large power reactors. Some have been called "Zero" power reactors because their power is so small it is essentially zero. They barely go critical. With them, we are rediscovering in the reactor business an old engineering truth that it is easy to assess most technical variables when they are isolated in equipment designed to study only these variables.

When interested in examining only the nuclear aspects of a design for a reactor, one finds that he can build a cheap nuclear mockup—also called a critical assembly or a zero power reactor—with no worries about temperature, radiation damage, heat transfer or corrosion. It is not necessary to contain pressure, confine radioactivity or provide for thermal expansion or fluid flow. Yet the fruits from such machines are many.

Stages of Development

Let us consider four stages in the development of a reactor: conceptual design, engineering design, manufacturing and operation.

During conceptual design, the service of a flexible nuclear mockup—one that can be rebuilt with different arrangements of fuel — is invaluable. Data most easily determined with such a critical assembly include lattice parameters, fuel loading, control rod placement and programming, temperature coefficient of reactivity, and heat generation patterns. These numbers must be chosen before engineering parameters such as coolant flow and pipe sizes can be fixed.

During the very earliest stages of design, some of this work can be done on a mockup of less than critical size when used with a standard neutron source such as a radium-beryllium gun. Such a subcritical assembly, or exponential experiment, can save a lot of money but, of course, is less versatile than a full critical assembly. You will recall that more than a score of exponential experiments were built preliminary to the assembling of the first reactor in Chicago in the fall of 1942.

Critical Assembly

After the engineers have set the conceptual design of the large reactor, they use a less flexible and more detailed critical assembly. It helps to answer such questions as the effect of gaps and structural parts on heat generation and neutron flux patterns, the streaming of neutrons through coolant and instrument channels, shadowing effects of adjacent control rods and the effect of fuel burnout and fission product build up on reactivity and power distribution.

During the manufacturing stage, a zero power reactor can be used to check the reactivity of samples of materials intended for core parts. Whole

fuel elements and control units can be tested, before they are installed.

Even after the big reactor goes into operation, the need for a zero power nuclear facsimile does not stop. For example, since the mockup can be instrumented much easier than the large reactor, operating problems that arise with the large reactor probably can be studied best by the mock-up.

Another type of auxiliary reactor is one for testing promising materials. High power and associated high flux are desirable because they make possible accelerated life tests but are not abso'utely essential. We have used low power reactors as well as the Canadian NRX reactor, with the generous cooperation of our neighbor, and in recent years our own new high flux Materials Testing Reactor.

Here, again, beginners could well learn to walk before attempting to run. Experience with low power reactors can gradually build up skill and confidence which will eventually be necessary for the operation of high power reactors. The amount of research needed on materials is so infinitely large that all researchers need not have at their disposal the ultimate in testing equipment. The initial separation of promising from unpromising materials and alloys can be made in relatively inexpensive reactors and the final testing of the most promising items in a few strategically located high flux reactors.

Ambergris Manufacture Possible?

➤ LABORATORY production of one of the most expensive and rarest materials used in perfumery, ambergris, may be possible, Dr. Robert Clarke of Britain's National Institute of Oceanography at Worm'ey, Surrey, has suggested in connection with making known the great haul of almost a half a ton of this material during the last Antarctic whaling season.

This material, which is sometimes found floating in the sea but more often is obtained in connection with whaling kills, is still a valuable commodity without equal as a fixative in perfumes.

Scientists have not been able to agree just how it is formed except that it is a result of unusual digestive processes in the whale.

A boulder of ambergris, weighing 926 pounds, was found in the large intestine of a bull sperm whale 49 feet long, being cut up on board the floating factory, "Southern Harvester," last December. Only four other finds of ambergris exceeded this weight, but three of them may not have been taken from one whale.

Dr. Clarke has concluded that ambergris is formed by the chemical transformations within the intestines of waste products of the whale's digestion. He believes that it may be possible to produce ambergris in the laboratory by incubating such waste material from the whale under suitable conditions, and because of the value and rarity of the material, this problem might be worth working upon.

Atomic Scientist of the Future Makes Amazing Discovery

New Source of Power?

For the amusement of its readers, CHEMISTRY reprints the following, with a bow to The American Chemical Society's Chemical and Engineering News, where the original article and the letter of comment first appeared.

Scientific investigations that deal with the problem of energy requirements are always welcome. Author of the following communication, O. R. Frisch, Cambridge, England, is especially qualified to discuss the subject. A renowned nuclear physicist, he formerly occupied a high post in the Harwell Atomic Energy Establishment.

➤ THE RECENT discovery of coal (black fossilized plant remains) in a number of places offers an interesting alternative to the production of power from fission. Some of the places where coal has been found show signs of previous exploitation by prehistoric men who, however, probably used it for jewels and to blacken their faces at religious ceremonies.

The power potentialities depend on the fact that coal can be readily oxidized with the production of a high temperature and an energy of about 0.0000001 megawatt day per gram. That is, of course, very little, but large amounts of coal (perhaps millions of tons) appear to be available.

The chief advantage is that the critical amount is very much smaller for coal than for any fissile material. Fission plants become, as is well known, uneconomical below 50 megawatts, and a coal-driven plant may be competive for small communities (such as small islands) with small power requirements.

The main problem in the design of a coal reactor is to achieve free, yet controlled access of oxygen to the fuel elements. The kinetics of the coal-oxygen reaction are much more complicated than fission kinetics, and not yet completely understood. A differential equation which approximates the behaviour of the reaction has been set up, but its solution is generally difficult.

It is therefore proposed to make the reaction vessel in the form of a cylinder, with perforated walls to allow the combustion gases to escape. A concentric inner cylinder, also perforated, serves to introduce oxygen, while the fuel elements are placed between the two cylinders. The necessary presence of end plates poses a difficult but not insoluble mathematical problem.

It is likely that fuel elements will be easier to manufacture than in the case of fission reactors. Canning is unnecessary and indeed undesirable since it would make it impossible for the oxygen to gain access to the fuel. Various lattices have been calculated, and it appears that the simplest of all —close packing of equal spheres—is likely to be satisfactory. Computations are in progress to determine the optimum size of the spheres and the re-

quired tolerances. Coal is soft and easy to machine; so the manufacture of the spheres should present no problems.

Pure oxygen is of course ideal as an oxidant but costly; it is therefore proposed to use air in the first place. However, it must be remembered that air contains 78% nitrogen. If even a fraction of that combined with the carbon of the coal to form the highly toxic gas cyanogen this would constitute a grave health hazard (see below).

To start the reaction one requires a fairly high temperature of about 968 degrees F.; this is most conveniently achieved by passing an electric current between the inner and outer cylinder (the end plates being made of insulating material, such as ceramic). A current of several thousand amperes is needed, at some 30 volts, and the required large storage battery will add substantially to installation costs.

There is the possibility of starting the reaction by some auxiliary self-starting reaction, such as that between phosphine and hydrogen peroxide; this is being looked into.

Once the reaction is started its rate can be controlled by adjusting the rate at which oxygen is admitted; this is almost as simple as the use of control rods in a conventional fission reactor.

The walls of the reactor must withstand a temperature of well over 1000 degrees F in the presence of oxygen, nitrogen, carbon monoxide, carbon dioxide, as well as small amounts of sulfur dioxide and other impurities, some still unknown. Few metals or ceramics can resist such gruelling conditions. Niobium with a thin lining of nickel might be an attractive possibility, but probably solid nickel will have to be used. For the ceramic, fused thoria appears to be the best bet.

The main health hazard is attached to the gaseous waste products. They contain not only carbon monoxide and sulfur dioxide (both highly toxic) but also a number of carcinogenic compounds such as phenanthrene and others. To discharge those into the air is impossible; it would cause the tolerance level to be exceeded for several miles around the reactor.

It is therefore necessary to collect the gaseous waste in suitable containers, pending chemical detoxification. Alternatively, the waste might be mixed with hydrogen and filled into large balloons which are then released.

The solid waste products will have to be removed at frequent intervals (perhaps as often as daily), but the health hazards involved in that operation can easily be minimized by the use of conventional remote-handling equipment. Waste could be dumped at sea.

There is a possibility—though it may seem remote—that the oxygen supply may get out of control; this would lead to melting of the entire reactor and the liberation of vast amounts of toxic gases. Here is a grave argument against the use of coal and in favor of fission reactors which have proved their complete safety over a period of several thousand years. It will probably take decades before a control system of sufficient

reliability can be evolved to allay the fears of those to whom the safety of our people is entrusted.

What Will the Scientists Think of Next?

DEAR SIR:

➤ I READ with considerable interest the communication of O. R. Frisch in the Aug. 23 C&EN "News-Scripts," page 3400. Evidently Frisch is not aware that several investigators in this country have considered the possibility of producing energy by the combustion of coal.

A lattice of close-packed spheres, which Frisch suggests, is not satisfactory. As the reaction proceeds, the spheres will shrink. Since the reaction occurs only at the surfaces, its rate will decrease. This problem has been solved by machining the coal into hexagonal plates and boring holes of suitable size through the plates. This ensures constant surface during the course of the reaction.

Starting up the reaction is in fact more difficult than Dr. Frisch supposes. Passing a current through the pile is the best means known, but because of the low conductivity of the coal and the need for raising the temperature of the entire mass to about 1000° F., a voltage of 2000 to 5000 is required. This will put a current of some 2000 amperes through a properly designed one-ton pile and bring the temperature to about 1000° F. in a few minutes. Thereafter the reaction will be self sustaining.

The only practical method for achieving this is to have two coal piles in operation. As one of these approaches complete reaction, it is used to provide energy for driving a dynamo which in turn provides current to start up the second pile. Then the first system is taken down, waste products are removed, and a new coal lattice is built up to be ignited later by energy from the other pile. This duplication is of course expensive and, further, poses the problem of startup in isolated communities.

Of far greater importance, however, than the use of coal as a source of controlled power is its potential use as a military explosive. When coal is finely powdered and dispersed as an aerosol in oxygen, its combustion occurs with explosive speed and is capable of causing heavy destruction over a radius of from several dozen to several hundred feet from ground zero. This introduces possibilities of controlled bombardment of small, precisely-defined areas. Such weapons can be used by individual soldiers at close quarters. Although military security does not permit disclosure of the sizes of weapons, methods of triggering, etc., it is clear that this development will revolutionize warfare.

West New York, N. J. IRVING REICH

What Puts Nip in Catnip

➤ THE STUFF in catnip that makes it the favorite nip of cats is nepetalic acid, Prof. Samuel M. McElvain of the University of Wisconsin announced at the University of Illinois Now scientists can attempt to find out why cats like this essence of catnip so much.

For The Home Lab

Organic Reactions: Reduction

by BURTON L. HAWK

▶IN DISCUSSING the oxidation reaction, we stated that it consisted of "adding" oxygen to a compound. And in considering nitration, we found that this reaction consisted of "adding" the nitro group to a compound. Now we have *reduction*, which is the process of "adding" hydrogen to a compound. Consequently, the reaction is sometimes referred to as "hydrogenation." It also includes the replacement of an oxygen, halogen, or sulfur atom by hydrogen.

Reducing agents are those compounds which readily provide a source of hydrogen. Hydrochloric acid and metal (zinc, tin, or iron) are the most popular reducing agents. In organic chemistry, sodium metal, sodium amalgam, stannous chloride or titanous chloride with acid, hydriodic acid, and sodium sulfite are some of the others used. Molecular hydrogen itself may be used if a proper catalyst is employed (such as platinum, palladium, nickel, or copper chromite).

Organic compounds do not seem to like being reduced as well as they do oxidized. We find that the process of reduction is more difficult to carry out in the laboratory. In most cases the presence of a specially prepared catalyst is necessary.

The classic example of a reduction process is that of nitrobenzene to aniline. In a previous article we described the nitration of benzene to obtain nitrobenzene. You may prepare nitrobenzene in this manner for use here. Place about 2 cc. of the nitrobenzene in a large test tube. Drop in several small pieces of tin and add 5 cc. of hydrochloric acid. Gently heat the tube and shake occasionally to keep the reaction going at a steady rate. If necessary, add more tin or acid. The liquid will gradually turn dark brown in color. This is crude aniline. In the reaction, the oxygen in the nitro group (NO_2) of the nitrobenzene is replaced by hydrogen to form the amino group (NH_2); thus we have *amino*-benzene (aniline) instead of *nitro*-benzene.

It would be a shame to make aniline without preparing at least one colorful dye. So, in passing, suppose we consider mauve. Stir one teaspoonful of bleaching powder in 200 cc. of water and add a drop or two of the aniline. Stir and filter. Note the lovely shade of violet which can be varied in depth by diluting with water.

Aniline is not the only product formed from the reduction of nitrobenzene. If zinc dust and acid are used in the presence of ammonium chloride, *phenylhydroxylamine* is obtained. If the reduction is carried out in alkaline solution, *hydrazobenzene* is obtained. If nitrobenzene is reduced by electrolysis, *nitrosobenzene* is obtained. Thus, our product depends upon the type of reducing agent used in a certain environment.

In our oxidation reactions, we prepared formaldehyde and acetaldehyde from the corresponding alcohols (me-

thyl and ethyl). Now, if we take the aldehydes—can we reduce them to obtain the alcohols? Place a few cc. of each aldehyde in separate test tubes. Add several pieces of zinc to each followed by a small quantity of dilute HCl. Allow the hydrogen to bubble through the so!ution for a few moments, then heat each solution just to boiling. Allow to cool slightly, then heat again. Repeat this process several times, adding more zinc or acid if necessary. The reduction is very slow without a catalyst; however, you may be able to obtain a small quantity of the alcohol. Filter the formaldehyde so'ution. Add some salicylic acid to the filtrate along with about 5 drops of con. sulfuric acid. Heat gently and smell *very cautiously*. Do you recognize any odor of wintergreen indicating the presence of methyl alcohol? Treat the acetaldehyde solution similarly, using sodium acetate instead of the salicylic acid. This time see if you can recognize the fruity banana-like odor of ethyl acetate. Don't be too disappointed if you do not obtain phenomenal results. Our main point here is to illustrate the difficulty of reduction as compared with the ease of oxidation. As stated before, a catalyst must be employed for best results. In this reaction, finely divided nickel is often used. The nickel is prepared by the careful reduction of nickel hydroxide with hydrogen. We do not recommend this procedure for the home lab at this time.

We list below some other samples of the reduction process:

Acetamide is reduced to ethylamine by treatment with metallic sodium and amyl alcohol.

Acetylene can be reduced with an acid solution of chromous chloride to form ethene.

Aluminum ethoxide, prepared by the interaction of aluminum meta with ethyl alcohol in the presence of mercuric chloride, is an excellent agent for reducing various aldehydes and ketones to the corresponding alcohols.

Benzene can be reduced directly with hydrogen using a nickel catalyst. The product is cyclohexane.

Carbon tetrachloride is reduced to chloroform by the action of finely divided iron and water in the presence of the inevitable catalyst.

Ethane is obtained by the reduction of ethyl ether. In this case the reducing agent is hydriodic acid and red phosphorus.

Glucose can be reduced with sodium amalgam and water to form D sorbitol. Upon further reduction, hexane is obtained.

With the aid of catalyst, heat and pressure, hydrogen will reduce methyl alcohol to methane.

* * *

'So much for the reduction reaction. Although the quantity of these reactions that can be illustrated by home experiments is limited, we hope that we have given you some idea of the reduction procedure. At least, do not be like the high school girl who asked the chemistry teacher for a supply of reducing agents. The puzzled teacher asked her what she wanted to do with them.

"Why, I want to *reduce*, of course," she replied.

New Inert Rubber Contains Fluorine

Rubber to be Boiled in Oil

➤A NEW SYNTHETIC rubber that can stand being boiled in oil was announced at the meeting of the American Chemical Society in New York.

Important uses in military aircraft for the rubber, which withstands oils, gasoline and temperatures up to 400° F., were foreseen by P. J. Stedry, a chemist in the central research department of the Minnesota Mining and Manufacturing Company, St. Paul, Minn. Dr. J. F. Abere, a chemist who is section leader of that department's colloid section, was co-author of the report.

The fluorine-containing rubber, known as Poly-FBA, is now in small-scale experimental production, according to Mr. Stedry.

The nation's aircraft designers are constant'y striving to improve the efficiency and speed of military engines, Mr. Stedry said. Their demands place a heavy burden on all materials of construction. Above 300°, common lubricants and hydraulic fluids decompose or burn, and initially elastic rubber components become hard and brittle.

New high temperature fluids were successfully developed to replace the old petroleum derivatives, but they were found to attack and swell all known rubber compounds. Gaskets, seals, hose, and other essential flexible engine components failed rapidly when exposed to the combined deleterious effects of high temperature and synthetic fluids.

Since commercial rubber developments had not kept pace with the demands of modern aircraft design, the Wright Air Development Center of the U. S. Air Force has initiated an extensive program of rubber research. Work is in progress on a contract basis in many industrial and academic laboratories, as well as in the Materials Laboratory at Wright-Patterson Air Force Base, Ohio. One objective of this research is a solvent-resistant and chemically stable rubber with serviceability over the widest possible temperature range.

Synthesis of fluorine-containing polymers appeared to be a promising approach to the attainment of the desired goal, because known fluorinated liquids, greases, and plastics possessed outstanding thermal stability and chemical inertness. Since Minnesota Mining & Manufacturing Co. had a basic position in the chemistry of organic fluorine compounds, it was awarded one of the contracts. During the past four years, a substantial number of polymers and copolymers containing fluorine have been prepared and evaluated in the Central Research Departmnt of 3M Company. One of them, technically known as 1,1-dihydroperfluorobutyl polyacrylate and abbreviated as Poly FBA, has shown outstanding promise and has reached pilot plant production.

The raw material (monomer) for Poly-FBA preparation is derived from perfluorobutyric acid, a product of the

Simons-3M electrochemical cell, by a series of chemical reactions. After careful purification, the monomer is emulsified with water and converted into a stable rubber latex, from which white Poly-FBA gum can be obtained by coagulation and drying. This raw gum contains about 52 per cent by weight of chemically combined fluorine, and has higher density and lower refractive index than other synthetic elastomers.

Elastic articles are manufactured from the gum by compounding and vulcanizing on standard rubber processing equipment. Poly-FBA can be milled, calendared, extruded, molded, or applied directly from the latex or from solutions in fluorinated solvents. It differs in basic chemical structure from natural and common synthetic rubbers, and cannot be vulcanized with sulfur, but other materials known as polyamines accomplish the same purpose.

Carbon blacks or other fine pigments are used to reinforce the finished product. Most frequently, Poly-FBA is mixed with vulcanizing agents, reinforcing pigments, and other desired chemicals on a rubber mill, and the plastic mixture is then shaped by extrusion or molding and vulcanized by heat.

Poly-FBA vulcanizates possess outstanding resistance to deterioration by many solvents, oils, or acids, and swell less than 25 per cent in benzene, kerosene, gasoline, or high octane aviation fuels. Their serviceability at high temperatures is even more important to the Air Force. Tests have shown that parts fabricated from Poly-FBA function satisfactorily for long periods of time when immersed in synthetic lubricants and hydraulic fluids at temperatures up to 400°.

In addition, they are not attacked by ozone, which is frequently present in the vicinity of spark-producing engine parts. The chemical inertness and high temperature stability of Poly-FBA vulcanizates cannot be attained by compounding any other known synthetic rubber.

Although Poly-FBA rubber is not exceptionally tough, its tensile strength and other mechanical properties are adequate for many important applications. The principal shortcoming of this new rubber is its limited low temperature flexibility. It stiffens and becomes brittle at about zero degrees.

Poly-FBA is not intended to replace the more abundant and cheaper rubbers, but to serve in new and specialized applications. Its first use will probably come in military airplane engines as O-ring seals, gaskets, diaphragms, hose, etc. Advances in manufacturing and compounding technology will probably lead to applications in commercial aircraft and automobiles. It is hoped that Poly-FBA will eventually find its way into other industrial and consumer goods where its unique properties may bring about greater efficiency and longer life.

New formulas for lacquer thinners are improving automotive finish quality.

An instrument can detect scratches as small as one millionth of an inch.

Fluorocarbon Compound Retards Evaporation

Film to Cut Gasoline Storage Loss

➤A CHEMICAL "blanket" for stored gasoline and oil, which would greatly reduce fire hazards, costly evaporation losses and air pollution, was described at a recent meeting of the American Chemical Society.

Members of a new class of chemical agents, known as fluorocarbon surfactants, retard evaporation by forming an extremely thin, invisible film on the surface of petroleum products in storage, explained George B. Blake, chemical engineer of the Minnesota Mining and Manufacturing Company, St. Paul, Minn. The surfactants are effective even when added in quantities as small as two thousandths of 1 per cent of the gasoline weight, he declared. The word surfactant, a contraction of surface active agent, refers to a chemical that can change the surface properties of a liquid.

Mr. Blake pointed out that the suppression of evaporation would reduce toxicity and fire hazards. Some major smog problems have been laid to the presence in the air of petroleum vapors from refinery storage tanks.

The present losses through evaporation during the handling and storing of petroleum products are quite large, he said. His experiments demonstrated that more than 75 per cent of the treated gasoline still remained after an equal volume of the untreated gasoline was completely evaporated. The additive used in this case was three-thousandths of 1 per cent of a surfactant ca'led F-2.

The added agent has no apparent effect on the value of the gasoline, he reported, for when standard engine knock tests were made with the treated gasoline, there was no decrease in the octane number.

Practical uses for this type of compound are being studied in the laboratory, said Mr. Blake, who proposed a number of potential applications.

Some measurements have been made on the effect of one of the surfactants when added to a standard fuel oil base insecticide, he observed. The results of this investigation are very preliminary but show that almost twice the normal kill of houseflies was obtained when a small quantity of an appropriate fluorocarbon sufactant was added to the mixture.

The possibility of using such an agent in lubricating oils and greases has been suggested. The data show that this class of surfactants is capable of producing a significant surface effect in a standard lubricating oil by enhancing its wetting or penetrating properties. Evaluation of such a lubricant has not been carried far, but it is conceivable that it may improve the lubricating properties of the oil.

The behavior of certain surfactants in waxes has suggested applications where waxes are used to coat or impregnate such materials as paper and textiles. They should give better penetration of the wax and a!so improve the spreading characteristics.

Some possible industrial uses, Mr.

Blake noted, include a money-saving improvement of efficiency in the distillation of petroleum products and a remarkably good performance as flotation agents in ore refining. There should be many other applications for surfactants, such as adding desirable properties to paints, inks and cosmetics.

Although these surfactants are of particular value when added to petroleum products, some of the compounds are also quite effective in water. Other surface active agents have been used for years where water is the solvent to promote and improve detergency, wetting, spreading and other properties.

The fluorocarbon surfactants all contain the chemical element fluorine, Mr. Blake stated. They differ from other surfactants in that they can be used with hydrocarbon liquids and are relatively insoluble. They function by substantially reducing the liquid's surface tension—the force which draws the surface of a liquid together and forms drops.

Rubber Vulcanized by Atomic Radiation

➤ RUBBER vulcanized without sulfur or other chemical agent is produced by atomic energy in Britain's nuclear reactor pile at Harwell.

Oxidation is not a factor in this atomic energy vulcanization process. Contrary to widely accepted theory, the hardening change in rubber structure can take place when no oxygen can get to the material.

Energy alone is responsible for the change in structure of the rubber, since the same result is obtained no matter what type of radiation from the atomic reactor is used.

Similar changes in the structure of paraffin waxes irradiated in the pile result in a material with a very high melting point.

Theoretical explanations of these changes in structure as the result of atomic irradiation may lead to new applications of atomic energy in the production of new plastics and other useful materials. The studies in progress are reported by Dr. Arthur Charlesby of the Atomic Energy Research Establishment in Proceedings of the Royal Society and in the journal *Atomics*.

New Kind of Silica

➤ A NEW KIND of silica has been produced and identified by Dr. Paul R. Keat, now of the Norton Co., Worcester, Mass., during graduate work at Rutgers University, New Brunswick, N. J.

It is a very fine crystalline substance less dense and with a lower refractive index than quartz, the silicon-oxygen combination that is familiar in sand. It was manufactured under high temperature and pressure during laboratory experiments, using silicic acid or silica gel as the source of the silica.

The structure of the new silica is unique and seems to be the cause of a slight contraction with temperature up to about 550 degrees C.

A-Bomb Protection Possible From New Blood Protein

Discoveries in Blood Chemicals

➤ DISCOVERY of a protein in blood which seems to play an important part in giving a person natural immunity to germ and virus diseases is reported by Dr. Louis Pillemer and associates of Western Reserve University.

This protein might even become useful medicine to save lives of some A and H bomb survivors.

The newly discovered blood chemical has been given the name *properdin,* from the Latin word *perdere,* which means to destroy.

Properdin is not the same as antibodies, another class of blood substances that give immunity to specific diseases. It is found in Fraction III of blood serum when this fraction is separated by the Deutsch method.

It acts only in conjunction with another blood substance, called complement, and magnesium. It takes part in such varied activities as destruction of bacteria and neutralization of viruses, and destroys certain red blood cells.

Properdin, normally present in human blood serum, is destroyed by irradiation. Its destruction by radiation from A-bombs may be responsible for the infection which, in spite of antibiotics, would probably kill many survivors of A and H bomb attacks. Since it can be obtained in good yield from both human and cattle blood serum, it might be possible to use it to save lives of any future A or H bomb victims.

Recent reports by other scientists show that mice can be partly protected from irradiation by injections of fractions of blood serum, particularly Fraction III which is now shown to contain properdin.

Properdin has been found in the blood serum of rats, mice, cows, hogs, humans, rabbits, sheep and guinea pigs. Other animals have not yet been tested. Of the warm blooded animals tested, the rat has the most, the guinea pig the least, and humans are in between. This further strengthens the idea that properdin is important in natural immunity. This is the kind that enables people and other animals to resist disease without being vaccinated and even when they have not had previous contact with the disease that might have made their bodies develop antibodies to it. Rats are known to have a lot of this natural immunity, being very resistant to disease, while guinea pigs are quite susceptible.

Associated with Dr. Pillemer in the work on properdin were: Drs. Livia Blum, Irwin H. Lepow, Oscar A. Ross, Earl W. Todd, Alastair C. Wardlaw and A. R. Moritz.

Rare Blood Substance

➤ A VERY RARE blood substance may be responsible for habitual abortions, or miscarriages, in certain women, Dr. Philip Levine and Elizabeth A.

Koch of the Rh Blood Testing Laboratory, Ortho Research Foundation, Raritan, N. J., report.

The blood substance is an antibody called anti-Tja. It was discovered by Dr. Levine and associates in 1951 in the blood of a 66-year-old woman with cancer of the stomach. The antibody from this patient's blood serum clumped or broke down red cells in more than 5,000 random bloods of all groups and Rh types except that of the patient's physically normal 45-year-old sister.

The anti-Tja substance has now been found in the blood of 12 other persons living in South Africa, Australia, Poland, the United States, Canada and Japan.

Only the first of these 13, the patient in whom it was originally discovered, had cancer.

Anti-Tja was found in three men. Among five married women having it, there are a total of 18 pregnancies, each of which ended in a miscarriage at two to five months. Only the original patient and her sister, who subsequently showed anti-Tja in her blood, had normal pregnancies with babies born at term and still living and well.

A remarkable feature of the situation is that the miscarriages all occurred early in pregnancy. Drs. Levine and Koch point out that antibodies for Rh and other blood destroying disease do not cause death until the baby is almost ready for birth or has already been born.

This very rare blood antibody, specific for a factor present in almost all bloods, may be responsible for habitual miscarriages in certain persons. But the scientists point out that such a mechanism cannot explain the "vast majority" of early abortions unless future studies show up antibodies that cannot be detected by present methods.

RH Blood Tolerance

➤ A WOMAN with Rh negative blood whose mother had Rh positive blood is likely to develop some tolerance to Rh positive blood that helps when she meets it in her unborn child.

The help apparently is to the daughter but does not extend to the grandchild. That is, the mother's tolerance to Rh positive blood apparently does not prevent the serious blood-destroying condition that may develop in her child if its father is Rh positive.

Discovery of this actively acquired tolerance to Rh positive blood was announced by Drs. Ray D. Owen, Harold R. Wood, Alvin G. Foord, Phillip Sturgeon and L. G. Baldwin of Pasadena and Los Angeles in a report to the National Academy of Sciences.

Rh negative women whose mothers are also Rh negative, however, are not as likely to show tolerance to Rh positive blood.

The differences in tolerance to Rh positive blood show in tests of the mother's blood but not when developments of erythroblastosis, the condition in babies whose parents have opposite Rh types, is used as a sign of Rh tolerance.

The mechanism by which an Rh negative woman has acquired some Rh tolerance from her Rh positive mother is not known. It might be

either through the Rh antigen itself or intact cells of the mother getting into the daughter's blood before birth.

The studies were made at the California Institute of Technology and Huntington Memorial Hospital, Pasadena, and Children's Hospital, Los Angeles.

Ulcers and Cancer

➤ A LINK between blood groups and stomach cancer, peptic ulcer, toxemia of pregnancy and, perhaps, lung cancer has been discovered.

People with Rh negative blood might be a little less likely to develop lung cancer of the kind some authorities believe most closely related to cigarette smoking than Rh positives.

Blood group A is found oftener in patients with stomach cancer than in the general population of the locality in which the patients live.

Blood group O, on the other hand, occurs much oftener in patients with peptic ulcer and in women who develop toxemia of pregnancy.

Persons of blood group O are about 35% more likely to develop peptic ulcers than are persons of other blood groups.

These findings were announced in the British Medical Journal by three groups of scientists: Drs. Ian Aird, H. H. Bentall, J. A. Mehigan and J. A. Fraser Roberts of London, Drs. L. A. Pike and A. M. Dickins of Greenford, Eng., and Drs. R. B. McConnell, C. A. Clarke and F. Downton of Liverpool.

In one kind of lung cancer, known as the "oat-cell" type, more blood group A and fewer group O persons were found. This is not the cancer believed associated with cigarette smoking. It may be that this cancer has different causes, possibly with an inherited factor associated with the A blood group.

Cancers of the breast, rectum and colon showed no significant association with any blood group.

The reason for these relations between certain blood groups and certain diseases is not known. The simplest explanation might be that group A substance is cancer causing for the stomach, while both A and B substance protect against peptic ulcer. Dr. Aird and associates, however, say that much more work must be done to find the true reason for the relations.

Blood groups may have some selective value for survival, but it is surprising, the scientists state, to find relatively large blood group associations with diseases of middle and late life which are diseases of distinctly low selective value.

B-12 and Red Blood Cells

➤ WHY ARE some people unable to manufacture red blood cells normally?

The answer to this question is being sought at the Los Angeles Veterans Administration Center and the University of California at Los Angeles Medical School through the use of radioactive B-12.

This vitamin is known to be essential in the blood building process. However, without the aid of some body substance, known as the intrinsic factor, B-12 is not utilized, resulting in pernicious anemia. The nature and source of the factor has been a mystery.

Because intestinal bacteria also produce B-12, it has been difficult to trace experimentally administered B-12. However, with the use of the radioactive form, which can be traced with radiation detecting instruments, the stomach has been fairly well established as the source of the intrinsic factor.

When the radiovitamin was administered to persons whose stomachs had been removed because of cancer, it was found that none was absorbed. But with simultaneous administration of juices secreted by stomachs of healthy persons the B-12 was absorbed normally.

Actually it only takes a millionth of a gram of B-12 daily to maintain normal blood building activity. But without aid of some substance in stomach secretions, the vitamin apparently cannot negotiate the small fraction of a millimeter across the intestinal lining to the bloodstream.

Participating in the study are Drs. James Halsted, Marian Swendseid, Marvin Gasster and Ernst Drenick.

Body Steps Up Defense

➤ YOUR BODY is a "factory" which can convert to a "wartime footing" almost immediately, stepping up materials for defense as much as 500%.

This is indicated in research at the Los Angeles Veterans Administration by Dr. Charles Craddock of the University of California at Los Angeles Medical School.

Dr. Craddock is investigating production capacity of the body's blood factory which is the bone marrow. The research is concerned primarily with production of white blood cells, one of the body's most important defense mechanisms.

Animal studies have revealed that in addition to a prolific "peacetime" output of white blood cells, which builds up large reserve stocks, bone marrow production lines convert to a "wartime footing" when large numbers of white cells are needed for defense. This steps up white blood cell production to a phenomenal rate.

Even after "bombing" of the blood factory with X-rays, which seriously damage bone marrow, production was not greatly reduced until reserves were depleted.

Apparently when large numbers of white cells are removed from circulating blood, as would be the case in an infection, the marrow automatically steps up production to meet the demands.

The study, which is being supported by the U. S. Public Health Service and Parke, Davis and Co., is important not only to a fundamental understanding of blood formation but of such blood diseases as leukemia.

Blood Plasma Expander O.K.

➤ A SYNTHETIC chemical has now joined the ranks of non-synthetic blood plasma expanders that can be used to fight shock and death in case of war or other national emergency.

The synthetic is PVP, short for polyvinyl pyrrolidone. PVP has now had an effective new drug application filed with the Food and Drug Administration, Department of Health, Education and Welfare. In less technical terms, this means the chemical may be sold in interstate commerce.

Certain limitations, however, have been imposed on PVP. The effective

new drug application applies only to emergency use of PVP if blood, suitable blood plasma and other plasma volume expanders which are not stored in the body are not available. The other, not stored, plasma expanders are gelatin and dextran.

A second limitation provides that no more than 1,000 cubic centimeters, or about one quart, of PVP may be given to any one person in his lifetime. There is no such limitation on dextran or gelatin.

The reason for these limitations on PVP is that this synthetic chemical is stored in the body in organs involved in blood formation. Whether long-term, life-time storage of this synthetic chemical in the body could cause any damage is not known because the chemical has not yet been used long enough. Although not yet used in this country, it was used in Germany in World War II apparently without ill effect.

Our Food and Drug officials have decided that the safest course is to limit the use of PVP for the present while letting it become available in case of an emergency which would rapidly use up supplies of blood, plasma and other plasma expanders.

PVP is the first synthetic blood plasma expander to have an effective new drug application. It is made by the following four companies: Abbott Laboratories, North Chicago, Ill., Cutter Laboratories, Berkeley, Calif., General Aniline and Film Corporation, New York, and Schenley Distillers Corporation, New York.

Macadamia Nut Promising Crop

▶ A VALUABLE new crop will be added to California's agriculture, already the most highly-diversified in the world, if it lives up to the promise shown in experiments at the University of California at Los Angeles.

This is the macadamia, a tasty, high-oil-content nut native to Australia. It was introduced in Hawaii some time ago and has proved a commercially valuable crop there.

Propagation of the macadamia has been carried out successfully in a study in charge of Dr. C. A. Schroeder. This includes grafting of older trees in the field and nursery stock.

The research has included importation and testing of varieties of the nut from Hawaii, Australia and of local seedling trees. One variety has an unusually high oil content, up to 70%. This results in better storage and retention of a higher quality in commercial processing than those with lower oil content.

The macadamia has about the same frost tolerance as the avocado. Adapted to a wide range of soils, it has a high resistance, possibly a complete immunity, to avocado root rot. This may make it a suitable replacement crop for avocado orchards rendered valueless by the disease. The California Avocado Society is cooperating in the study.

Rulings to Take Hazard Out of Ammonium Nitrate

Science Into Law

Reprinted from the INDUSTRIAL BULLETIN *of Arthur D. Little, Inc.*

➤ IN THE PAST 40 years or so, there have been more than 25 major fires or explosions involving large quantities of ammonium nitrate. Yet U. S. production continues at about 1.5 million tons annually, to meet the demand for it in fertilizers, propellants, explosives, and in the manufacture of nitrous oxide, the dentists' "gas."

To safeguard both producers and the public, research on the decomposition of large quantities of ammonimum nitrate (AN) was initiated by the U. S. Government following the Texas City disaster in 1947. Results of this research have been translated into regulations, proposed by the Coast Guard, for safe handling and shipping of AN by water.

Immediately following the Texas City explosion, the Interagency Committee on the Hazards of Ammonium Nitrate initiated continuing studies to determine the behavior and properties of ammonium nitrate fertilizer mixtures.

Simultaneously, shipment of most such mixtures was restricted to isolated waterfront facilities meeting the Federal and local requirements for handling dangerous cargoes.

The Coast Guard regulations establish classifications of AN materials, arranged in decreasing order of hazard, from the wax-coated fertilizer grade (FGAN), which in quantity is effectively an insensitive explosive, down to grades considered only remotely hazardous.

As a first step, the possibility of spontaneous heating of AN was investigated; earlier AN fires and explosions had always occurred under such conditions that some other factor could be held responsible.

Consequently, the chemical reactions contributing to spontaneous heating were studied, as were the effect of temperature on reaction rates and the rate of heat flow through the sample.

For every sample and temperature there is a critical size below which spontaneous (or uncontrolled) heating will not take place because the heat generated can escape.

Above this size, spontaneous heating will occur, slowly at first, but increasingly faster, since the heating itself depends upon temperature.

Uncontrolled heating for a cargo-size pile of FGAN, the type that blew up at Texas City, will not occur unless the material is initially at a temperature above approximately 170°F.

The critical temperatures for other grades, of lower AN content, are correspondingly higher.

On the other hand, spontaneous heating may occur at substantially lower temperatures in mixed fertilizers containing organic material and ammonium nitrate.

Even taking critical size and temperature into account, it was at first difficult to see why AN should sometimes explode, and sometimes burn without explosion.

It was reasoned that an explosion implies a high rate of chemical reaction, which can take place only at a high temperature; thus if there is no explosion, something must limit the temperature that can be attained through spontaneous heating—under certain conditions!

That something was found to be a reaction in which AN dissociates into gaseous ammonia and nitric acid. This reaction absorbs heat, and therefore limits the possible temperature rise to a given maximum at any given pressure.

At atmospheric pressure, or near it, decomposition of AN can bring about fire, but cannot bring about explosion.

At pressures higher than atmospheric, the temperature-limiting reaction permits higher temperatures to be generated—high enough, in fact, to permit an explosion.

Thus in the interior of an AN cargo, packed tightly into the hold of a ship, for example, where venting may not be adequate to carry off the gases generated in decomposition, pressure can build up, the temperature can rise rapidly, and an explosion may result, as at Texas City.

The obvious next step for research on the problem was to specify safe limits of temperature and pressure.

A formula covering the various grades of AN has been worked out, and serves as the basis for the proposed shipping regulations.

In summary, a cargo of FGAN, the most hazardous grade, must be kept below about 170°F., and must be well ventilated.

Granulated, clay-coated AN without wax, the next lower grade, is considered a vigorous oxidizing agent; the limiting temperature for handling it safely is somewhat higher than for FGAN.

Chemically pure AN in drums is dangerous only above its melting point of 337°F., but in paper bags it is still hazardous, must be ventilated, and kept below 250°F.

Lower grades are increasingly safe, but still merit careful handling, since they have oxidizing properties.

For all grades of ammonium nitrate, the pending regulations require that the material be submitted for shipment at a temperature below 130°F., well below the hazardous limit for even the most reactive material when properly handled.

The immediate effect of adopting the new Coast Guard regulations will be to return ammonium nitrate to relatively free marine transport.

The further effects, in terms of public safety, will provide an outstanding example of problem-solving progress through heat technology.

Metal stitching has wider applications than welding; it can join plywood, rubber, plastics, leather, or asbestos to metal.

A mile of veneer for plywood has been peeled from one Douglas fir log, eight feet thick.

From Feldspathic Rock
To Ancient Literature

Ceramics—Now and Then

Reprinted from FOR INSTANCE, *American Cyanamid Company.*

➤ THE POTTER'S wheel still is symbolic of the ceramic industry but today automatic jiggers and assembly-line production largely have replaced the artistic device which ranks among man's earliest inventions.

Mass production methods assure greater uniformity in ceramic products like porcelains for tableware or for the prosaic but more exacting industrial uses. Conversely, mass production requires greater uniformity in raw materials and better control of the product during manufacture.

As a result the clay and other powdered materials now are superrefined, and chemical additives impart better control of consistency and strength of the wet clay.

Clay is the product of natural weathering of feldspathic rocks. Some 50 million years ago the rocks were pulverized by the turbulent conditions on the surface of the earth.

The powdered material was carried by rivers to shallow bays and lagoons and deposited to form the clay beds mined today. Clay particles range from coarse to extremely fine sizes but efficient methods now are available for separating them.

Uniformity and fineness in particle size of the clay permits the use of "dry mixing." In this time-saving process the clay and other raw materials are mixed first without water then the minimum amount of water is added for processing. This eliminates the removal of extra water necessary in older processes.

The wet mass from the "dry mixing" operation is formed into various shapes in jiggers or is molded and extruded by other machines. Automatic handling of the wet, unfired shapes demands that they have considerable "green" strength.

Obviously, green strength may be imparted by incorporating a water dispersible binder to hold the particles together during the forming and handling operations. However, the binder must not interfere with the properties of the final product.

In the firing operation it must either become a part of the ceramic or it must burn out completely without causing damage or shrinkage in the ceramic.

Extensive study of this problem has shown that a selected group of organic materials are most suitable as binders. These include special waxes and other organics which are emulsified for efficient incorporation into the wet clay.

The emulsions not only impart green strength, they also improve the consistency and flow properties during wet processing. Since the wet clay products vary in pH from alkaline to slightly acid, specific emulsions are designed for use under these conditions.

The potters handicraft through the ages has provided not only utility but

also art and matter for musing for those so inclined.

When Omar "in that old potter's shop stood alone, with the clay population round in rows" he couldn't help philosophizing. "Surely not in vain my substance from the common earth was ta'en; that He who subtly wrought me into shape should stamp me back to common earth again." And it did not seem that "He that made the vessel in pure love should in an after rage destroy."

The potters fictile art lends itself readily to the expression of ideas and changing circumstances.

This versatility provided the eminent historian, Sir Flinders Petrie, with evidence for placing in chronological order 1,000 prehistoric graves in Egypt. Each grave contained several forms of pottery but the presence of a new form or absence of an old type served to place the graves in correct time sequence.

Some of the earliest writing available is that inscribed in clay tablets by the Sumerians. "Nebuchadnezzar's Dictionary" of about 100 tablets made at a much later date, 700-600 BC, contains both Sumerian and Semitic meanings of the cuneiform script.

It was used by scholars when made, and was invaluable some 2600 years later to other scholars in deciphering cuneiform writing.

The ruins of the library of Assurbanipal, King of Ninevah, 668-626 BC, were discovered in 1850. Twenty-five years later a member of the British Museum was deciphering the cuneiform on the tablets and found a story of the Flood written before biblical times.

But, some tablets were missing. Could they be found among the debris in the ruins after it had been exposed for 25 years? A search for the almost impossible was rewarded with the missing tablets and a new and complete story of the Flood.

Archaeologists of the distant future discovering present day ceramics would find no trace of the wax emulsions which improved their processing, and our printed records are not as durable as those on clay tablets!

Hay Pellets Reduce Storage Space

➤ Long and chopped hay compressed into pellets can be stored in one-fifth the space needed for present hay storage. Smaller storage barns will result if the hay pellets go into wide use, H. D. Bruhn, University of Wisconsin farm engineer has predicted. The University is conducting feeding tests to discover the cow's reaction to the pellets. Several farm machine companies are watching the results with interest.

The machine press and the pellet's size are the researchers' greatest problems, Mr. Bruhn feels. The press he uses to make experimental pellets is slow and stationary. A commercial farm machine would have to be a fast machine designed for field use.

The pellets must be a size the cows like and can easily chew. Small pellets, Mr. Bruhn reported, will be swallowed whole by the cow and poorly digested.

Chemists Improve Common Materials

Chemical Patents

Copies of complete specifications may be ordered from the Commissioner of Patents, U.S. Patent Office, Washington 25, D.C. Order by patent number and remit 25 cents for each patent, by money order or Patent Office coupon, not stamps.

Golden-Toned Photographs

➤ AMATEUR photographers who like gold-toned enlargements of their best negatives but who wince at the cost of real gold toners now have a new toning developer to try out.

It is composed of four ounces, 80 grains of alkali sulfite; ¼ ounce of glycine; ¾ ounce of hydroquinone; nine ounces of alkali carbonate; four ounces of alkali bromide, and a gallon of water. These inexpensive chemicals are dissolved one-at-a-time in water of about 85 degrees Fahrenheit. The solution is used at 70 to 75 degrees Fahrenheit to develop the enlargement.

Inventor Vera Ficker of Mount Vernon, N. Y., who received patent No. 2,678,886, says the solution produces a "golden tone character" to the emulsion of the paper or plate.

Big Germanium Crystals

➤ MANUFACTURERS of electronic equipment now can grow large single crystals of pure germanium for transistor circuits in television sets, hearing aids and electronic brains.

The patent protects a process in which two thimble-sized ingots of germanium are melted in an electric oven while a breeze of helium blows over them. The helium will not oxidize the hot germanium as ordinary air would.

After the ingots have been kept molten at 1,800 degrees Fahrenheit for five hours, the oven temperature is lowered slowly. One of the germanium ingots becomes a "dummy load" and solidifies before the other ingot does. It gives off heat that helps stabilize the other ingot while it grows into a large single crystal.

The process was worked out by Karl M. Olsen of Parsippany-Troy Hills, N. J., who assigned patent No. 2,679,080 to Bell Telephone Laboratories, Inc., New York.

Fire-Retarding Coating

➤ A FIRE-RETARDING coating for walls in hazardous areas won patent No. 2,679,489 for George L. Cunningham of Cincinnati, Ohio, who assigned it to Waterloo Corporation, New York.

It is brushed on like paint to insulate wood or other combustible materials from the heat of a roaring fire nearby. It also has a foam-like structure that helps exclude the free passage of air to the coated surface.

The coating is made of urea and formaldehyde mixed with ammonium or zinc compounds of orthophosphates and borates. Thickening agents such as carboxyl methyl cellulose and methyl cellulose and polyvinyl alcohol are used in small quantities to give body to the coating.

Chemical Heating Pad

➤IF YOUR soldier son ever must fight in a frigid winter climate like Korea's he may be kept warm by new chemical heating pads built into his battle garments.

Philip J. Shapiro of Asbury Park, N. J., assigned patent No. 2,680,063 to the Army. It describes a mixture of iron particles and oxidizing agents that release heat when acted on by water.

Designed for Army clothes, the heating pads will warm up to 100 or 120 degrees Fahrenheit when water is added, and will stay this hot for 50 hours. Soldiers could use each heating pad five times, getting 250 to 290 hours of warmth from the chemicals. When exhausted, the heating pads could be replaced easily and quickly.

Jet Turbine Buckets

➤A NEW WAY has been found to cast hollow turbine blades for the engines of turbojet airplanes. It is easy to do and permits engineers to lessen the effect of overheating in this "mechanical heart" of the modern airplane.

Ducts in the turbine blades, through which flow air or other coolants, are first fashioned of a molybdenum wire, tube or strip. Then the blade is cast.

The resulting turbine bucket is heated in air at a temperature of 1,500 degrees Fahrenheit, causing the molybdenum to vaporize as molybdenum trioxide and disappear from the casting.

This leaves open passageways through which the coolants later will flow when the engine is in operation. The process even permits hair-like air passages to be formed in the hot-operating leading edges of the turbine buckets.

The method of making these hollow castings was worked out by Robert A. Kempe of Cleveland, who assigned patent No. 2,679,669 to Thompson Products, Inc., also of Cleveland.

Neutron Absorbing Alloy

➤A NEW ALLOY has been invented which, by its ability to absorb heat-producing neutrons, may be used to turn nuclear reactors on or off.

The alloy of indium, cadmium and bismuth would form part of the control rods that are shoved into a reactor when the atomic device is developing more heat than needed.

Inventors Leo F. Epstein and Marion D. Powers, both of Schenectady, and William H. Howland of Waterford, N. Y., who assigned patent No. 2,680,071 to the Atomic Energy Commission, report that the alloy melts at 142.7 degrees Fahrenheit.

The low melting point also makes it suitable for heat-transfer purposes, heat-treating baths, a dental alloy, bearings, solders, bending pipe and tubing, a casting alloy and a fusible alloy for sprinklers and fire-prevention systems, they report.

Antibiotic Gauze Pads

➤GAUZE PADS containing three germ-killing antibiotics have been invented to cut chances of infection when you are wounded at work, on the battlefield or when you are undergoing surgery in hospitals.

Wounds usually are infected with bacteria, but ordinary gauze pads do not offer protection against the spread of these germs. Body forces often are able to destroy the bacteria. But in

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battlefield wounds, so many bacteria may be carried into the body by shrapnel or bullets that the body's germ-combatting forces can be overwhelmed. This is particularly true when the soldier is unable to receive prompt surgical attention.

Invented by Frank R. Cusumano of Baltimore, who assigned patent No. 2,680,701 to Multibiotics Corporation of America, the gauze pad is impregnated with sterptomycin, bacitracin and polymyxin B. These antibiotics are first dissolved in methyl alcohol. After the pads have been saturated in the solution, the alcohol is quickly evaporated in a blast of warm air so that the germ-killing potency of the antibiotics is not weakened.

Fuel Strainer For Cars

➤ A FUEL STRAINER that snatches tiny flecks of iron from gasoline before they get to the carburetor has been invented by Henning W. Rundquist of East Lansing and Gilbert Burrell of Lansing, Mich., who assigned to General Motors Corporation, patent No. 2,680,519.

A small magnet, placed before the usual fuel strainer, monitors the gasoline as it heads toward the carburetor. It grabs the iron particles as they go by, leaving the rest of the cleaning operation to the fuel strainer. Tests have shown that iron flecks usually are the foreign bodies that clog fuel strainers.

Since finer-meshed strainers must be used to match improved, finer-nozzled carburetors, fuel filtering has become highly important to the performance of your car. The inventors believe their device will increase the life of fuel strainers in the future.

Textiles Flameproofed

➤ CLOTHING manufacturers can flameproof sweaters, bathrobes and smoking jackets with a chemical process. Perhaps even bed sheets could be treated at laundries to guard their users against possible burns if they fall asleep while smoking.

Textiles treated in a mixture of polyphosphonitrilic chlorides with polyhalopropyl alcohol refuse to support combustion even when a strip is lit at its bottom. The same strip, untreated, might burn completely, even when lit at its top.

Carl Hamalainen of New Orleans, who assigned patent No. 2,681,295 to the U. S. Department of Agriculture, declared that treated cotton fabrics retain much of their fire-resistant qualities after repeated launderings.

Inexpensive Hardboard

➤ HIGH-QUALITY hardboard now can be made more economically by an improved process that cuts down the time of manufacture. The process was invented by Orcutt W. Frost of Gaston and Gordon E. Tower of Forest Grove, Ore., who assigned patent No. 2,680,995 to Stimson Lumber Company.

Cellulosic fibers, such as are obtained from Douglas fir, are prepared in a slurry and mixed with a thermosetting resin. The slurry is "wet-lapped" on a wire screen and is given a "surface" treatment. Then heat and pressure are applied to coalesce the fibers into a hard, grainless board resembling lumber.

Current manufacturing procedures for this type of board involve a 14-hour baking stage after the pressing operation. This, the inventors say, is time-consuming and costly.

Proudly Presented

▶ STRAIN-FREE platinum-resistance thermometers announced recently by the American Instrument Co., Inc., Silver Spring, Maryland, are standards for measurements of the highest precision and accuracy, such as the calibration of other thermometers, measurements of freezing and boiling points, and temperature measurements in calorimetry. Range: minus 180° C. to plus 500° C.

These thermometers are made to comply with the requirements of the International Temperature Scale of 1948, and are calibrated by the National Bureau of Standards when customers so desire.

The Pyrex stems have a standard length of 18 in. Stems as short as 5½ in. can be made to order. The resistor is made of specially purified platinum. The stem is fitted with an aluminum head from which the four internal leads emerge in the form of a single cable 8 ft. long. The cable is separated near its end into four leads each fitted with a gold-plated copper terminal. Details are given in manufacturer's Bulletin 2247.

▶ A NEW DEVICE for changing ordinary tap water into the chemical equivalent of distilled water (in terms of specific resistance) for as little as ten cents a gallon is announced by Central Scientific Company, 1700 West Irving Park Road, Chicago, Illinois.

The new device, called Quikpure, is a 16-ounce polyethylene squeeze bottle, the bottom of which contains a mixture of cation and anion exchange resins. Tap water poured into the bottle comes into immediate contact with the resins and is converted to distilled water in about one minute.

A specially designed cap permits the user to discharge the distilled water from the squeeze bottle, but will not allow the resins to escape. They remain in the bottle and may be used repeatedly up to about 25 gallons of water, depending upon its hardness. When the resins cease to react, a color change occurs caused by the presence of a registered food, drug and cosmetic dye.

The monobed resin works as follows: cations, or positively charged particles, are exchanged for hydrogen ions; the anions, or negatively charged particles, are exchanged for the hydroxyl ions of the resin. The hydrogen and hydroxyl ions resulting from the two exchanges react almost instantly with each other to form H_2O and nothing else.

▶ HIGH-PURITY isopropyl ether reagent is offered as a Fisher Certified Reagent, made to rigid specifications, and with a lot analysis on each label. Water is below 0.05%, alcohol under 0.1%.

The catalog number is E-141. It is packaged in volume units, in standard containers instead of in a variety of weight units. Pint is about $2.35; quart, $4.35; gallon, $14. Manufacturer: Fisher Scientific Co., 717 Forbes St., Pittsburgh 19. In Canada: Fisher Scientific Ltd., 904 St. James St., Montreal 3.

Book Condensations

MODERN CHEMICAL PROCESSES: A Series of Articles Describing Chemical Manufacturing Plants—Editors of Industrial and Engineering Chemistry in conjunction with the technical staffs of the cooperating organizations —*Reinhold*, 276 p., illus., $5.00. Representing the most modern and up-to-date operations in production of various chemicals and related materials.

THE STATISTICAL APPROACH TO X-RAY STRUCTURE ANALYSIS—Vladimir Vand and Ray Pepinsky—*X-Ray and Crystal Analysis Laboratory, Pennsylvania State University*, 98 p., illus., paper, $1.50. Containing analyses and extensions of the theory of the statistical approach to phase determination in X-ray crystal analysis, as reported in the monograph by H. Hauptman and J. Karle.

NAME REACTIONS IN ORGANIC CHEMISTRY—Alexander R. Surrey—*Academic Press*, 192 p., $4.00. In organic chemistry there is a custom of designating many reactions by the names of the chemists who discovered or developed them; these "name reactions" constitute a considerable portion of the tools available to the organic chemist.

FUNDAMENTALS OF INORGANIC, ORGANIC AND BIOLOGICAL CHEMISTRY—Joseph I. Routh—*Saunders*, 3d ed., 418 p., illus., $4.00. This textbook has been brought up to date, and due to the increasing importance of atomic energy in the world, the sections on radioactive isotopes and atomic energy have been expanded and rewritten.

GENERAL CHEMISTRY: A Topical Introduction—Eugene G. Rochow and M. Kent Wilson—*Wiley*, 602 p., illus., $6.00. A textbook for the serious student, this presentation of chemical principles is not "watered down" but it is simplified.

PROCEEDINGS OF THE SECOND INTERNATIONAL CONGRESS ON RHEOLOGY: Oxford, 26-31 July, 1953—V. G. W. Harrison, Ed.—*Academic Press*, 451 p., illus., $10.00. On the deformation and flow of matter, dealing particularly with plastics and high polymers as well as lubricants, clays, metals, diamonds, and protoplasm.

A LINE FORMULA CHEMICAL NOTATION—William J. Wiswesser—*Crowell*, 149 p., $2.00. Describing a new method by which even complicated chemical structures may be expressed concisely and without ambiguity in a single line of letters, numbers and punctuation marks.

THE SCIENCE OF CHEMISTRY—George W. Watt and Lewis F. Hatch —*McGraw-Hill*, 2d ed., 546 p., illus., $5.50. The chapter on artificial radioactivity and atomic energy has been brought up to date and other parts of this textbook for non-science students have been completely revised. A section on nuclear fusion has been added.

THE FUNDAMENTALS OF COLLEGE CHEMISTRY — G. Brooks King and William E. Caldwell—*American Book Company*, 2d ed., 589 p., illus., $4.50. The chapter on radioactivity and nuclear changes has been largely rewritten and there has been substantial revision of other chapters.

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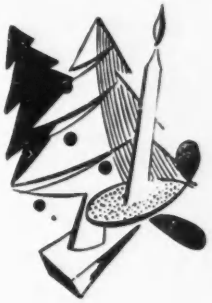

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